

Lantican, Flordeliza

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Philippine Institute for Development Studies

Vegetable Program Area Research Planning & Prioritization

Flordeliza A. Lantican

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The Research Information Staff, Philippine Institute for Development Studies
3rd Floor, NEDA sa Makati Building, 106 Amorsolo Street, Legaspi Village, Makati City, Philippines
Tel Nos: 8924059 and 8935705; Fax No: 8939589; E-mail: publications@pidsnet.pids.gov.ph
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FINAL REPORT

VEGETABLE PROGRAM AREA RESEARCH PLANNING AND PRIORITIZATION

FLORDELIZA A. LANTICAN

**PHILIPPINE INSTITUTE FOR DEVELOPMENT STUDIES AND
DEPARTMENT OF AGRICULTURE-BUREAU OF
AGRICULTURAL RESEARCH**

September 20, 1999

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LIST OF ACRONYMS

ANR	Agriculture and Natural Resources
ASIST	Abra State Institute of Science and Technology
AVRDC	Asian Vegetable Research and Development Center
BAR	Bureau of Agricultural Research
BAS	Bureau of Agricultural Statistics
BICARRD	Bicol Consortium for Agriculture and Resources Research and Development
BNAS	Bulacan National Agricultural School
BSU	Benguet State University
CAR	Cordillera Autonomous Region
C-CARRD	Caraga Consortium for Agriculture and Resources Research and Development
CSSAC	Camarines Sur State Agricultural College
CVARRD	Cagayan Valley Agriculture and Resources Research and Development
CV-CIRRD	Central Visayas Consortium for Integrated Resources Research and Development
DA	Department of Agriculture
DBM	Department of Budget and Management
DBM	Diamondback Moth
DENR	Department of Environment and Natural Resources
DOST	Department of Science and Technology
ESSC	Eastern Samar State College
FNRI	Food and Nutrition Research Institute
FRLD	Foundation for Resource Linkage and Development, Inc.
GATT	General Agreements of Tariffs and Trade
HARRDEC	Highland Agriculture and Resources Research and Development Consortium
ILARRDEC	Ilocos Agriculture and Resources Research and Development Consortium
ISCA	Ifugao State College of Agriculture
LGUs	Local Government Units
mt	metric ton
NARRDN	National Agriculture and Resources Research and Development Network
NARS	National Agriculture Research System
NOMCARRD	Northern Mindanao Consortium for Agriculture and Resources Research and Development
NVSIT	Nueva Viscaya State Institute of Technology
PAC	Pampanga Agricultural College
PCARRD	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
PSPC	Panay State Polytechnic College
PSU	Pangasinan State University
QSC	Quirino State College
R&D	Research and Development
RIARCs	Regional Integrated Agricultural Research Centers
SCUs	State Colleges and Universities
SMARRDEC	Southern Mindanao Agriculture and Resources Research and Development Consortium
STARRDEC	Southern Tagalog Agriculture and Resources Research and Development Consortium
UEP	University of Eastern Philippines
UPLB	University of the Philippines Los Baños
USM	University of Southern Mindanao
VICARP	Visayas Coordinated Agricultural Research Program
VISCA	Visayas State College of Agriculture
WESMARRDEC	Western Mindanao Agriculture and Resources Research and Development Consortium
WESVARRDEC	Western Visayas Agriculture and Resources Research and Development
WLU	Western Luzon University

Vegetable Program Area Research Planning and Prioritization

Flordeliza a. Lantican

In recent years, there has been a growing awareness of the significant role of vegetables in human health. Apart from their nutritional value, vegetables contribute significantly to the farmer's income when sold locally, and to the country's foreign exchange earnings if exported. Their production, packaging, processing and storage are labor-intensive and therefore can provide employment to a large segment of the labor force.

As minor component of the traditional cropping system, vegetables add diversity to the food commodities produced. Vegetable production is amenable to sustainable use of the resource base, soil and water, and the environment. As a component of an integrated crop and animal enterprises, vegetable production offers a sustainable approach in the farm production chain.

With the current economic crises which the Filipino farm family has to contend with, and the increasing reliance on food purchases to satisfy demand, the national agricultural productivity and food security programs have identified vegetable growing as an enterprise to augment cheaply available but highly nutritious food supplies. However, despite the recognized importance of vegetables, it has not generally been given the research attention it deserves. With its attendant problems vis-à-vis its potentials, vegetable production and marketing warrants research focus, fine-tuning, adequate physical and manpower investments, and prioritization.

This study aims to present an industry profile with focus on domestic production, consumption, external trade, problems/constraints, and market potentials; review past researches on vegetables, technologies generated/adopted, and the extent of participation of the private and public sectors; identify research and technology gaps for the vegetable industry; identify strengths and weaknesses in the institutional structure of research and extension interface, including physical and manpower investments, and research complementation efforts; and suggests recommendations and R&D agenda for the vegetable industry.

FINAL REPORT

VEGETABLE PROGRAM AREA RESEARCH PLANNING AND PRIORITIZATION¹

FLORDELIZA A. LANTICAN²

I. BACKGROUND

In recent years, there has been a growing awareness of the significant role of vegetables in human health. Experts claim that vegetables could address problems associated with blindness and anemia due to Vitamin A and iron deficiencies, respectively. Apart from their nutritional value, vegetables contribute significantly to the farmer's income when sold locally, and to the country's foreign exchange earnings if exported. Their production, packaging, processing and storage are labor-intensive and therefore can provide employment to a large segment of the labor force.

As minor component of the traditional cropping system, vegetables add diversity to the food commodities produced. Vegetable production is amenable to sustainable use of the resource base, soil and water, and the environment. As a component of an integrated crop and animal enterprises, vegetable production offers a sustainable approach in the farm production chain.

With the current economic crises which the Filipino farm family has to contend with, and the increasing reliance on food purchases to satisfy demand, the national agricultural productivity and food security programs have identified vegetable growing as an enterprise to augment cheaply available but highly nutritious food supplies. However, despite of the recognized importance of vegetables as earlier mentioned, it has not generally been given the research attention it deserves. With its attendant problems vis-à-vis its potentials, vegetable production and marketing warrants research focus, fine-tuning, adequate physical and manpower investments, and prioritization.

This study is an offshoot of the PIDS and DA-BAR collaboration in an attempt to make the industry economically viable through strengthening research and development planning and prioritization.

¹ Final report of research project commissioned by the Philippine Institute for Development Studies and the Department of Agriculture-Bureau of Agricultural Research.

² Associate Professor, Department of Agricultural Economics, College of Economics and Management, University of the Philippines Los Baños. The author acknowledges the excellent assistance provided by Ms. Cecilia M. Lantican and Ms. Gay Maureen Alagcan in the data collection, processing and preliminary analysis. She is also grateful to Dr. Rodel Maghirang of the Institute of Plant Breeding, UP Los Baños for reviewing the draft report.

Objectives

1. Present an industry profile with focus on domestic production, consumption, external trade, problems/constraints, and market potentials;
2. Review past researches on vegetables, technologies generated/adopted, and the extent of participation of the private and public sectors;
3. Identify research and technology gaps for the vegetable industry;
4. Identify strengths and weaknesses in the institutional structure of research and extension interface, including physical and manpower investments, and research complementation efforts; and
5. Suggest recommendations and R&D agenda for the vegetable industry to be used by DA-BAR in research planning and prioritization.

2. INDUSTRY PROFILE

2.1 Domestic Production

Vegetable production accounted for 8 % of the country's total production of agricultural crops in 1997. It grew by an annual average of 2 % in eight years from 4.5 million mt in 1990 to 5.1 million mt in 1997 (Figures 1&2). The growth was largely attributed to an improvement in yield per hectare of 1.2 % annually during the same period (Table 1).

Table 1. Average Annual Growth Rates in Production, Area Harvested and Yield, By Vegetable Type, Philippines, 1990-1997 (in percent)¹.

CROP	PRODUCTION	AREA	YIELD
Tomato	-1.1	-1.9	0.9
Eggplant	8.6	2.4	6.3
Cabbage	-0.9	-0.3	-1.1
Onion	5.3	9.9	-3.8
Garlic	3.2	5.0	-1.1
Mungbean	0.6	-0.1	0.6
Asparagus	31.6	27.5	2.1
Fruit-Bearing Vegetables	1.5	0.6	0.9
Leafy/Stem Vegetables	3.1	0.9	2.1
All Vegetables	2.0	0.8	1.2
All Agricultural Crops	1.7	-0.1	1.7

¹Data derived from Appendix Table 1

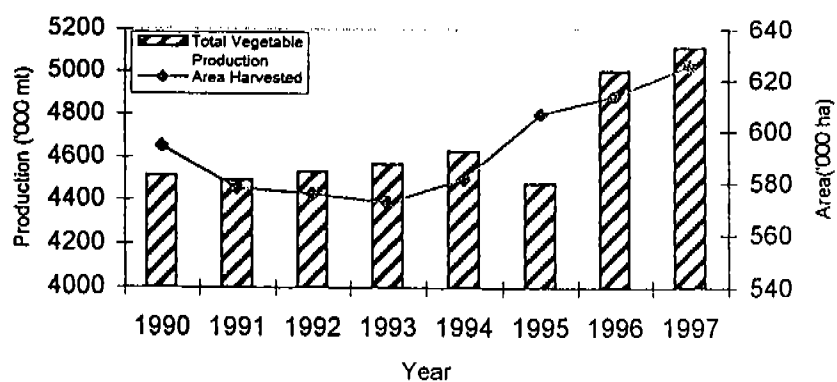


Figure 1. Vegetable Production and Area Harvested, Philippines, 1990-1997.

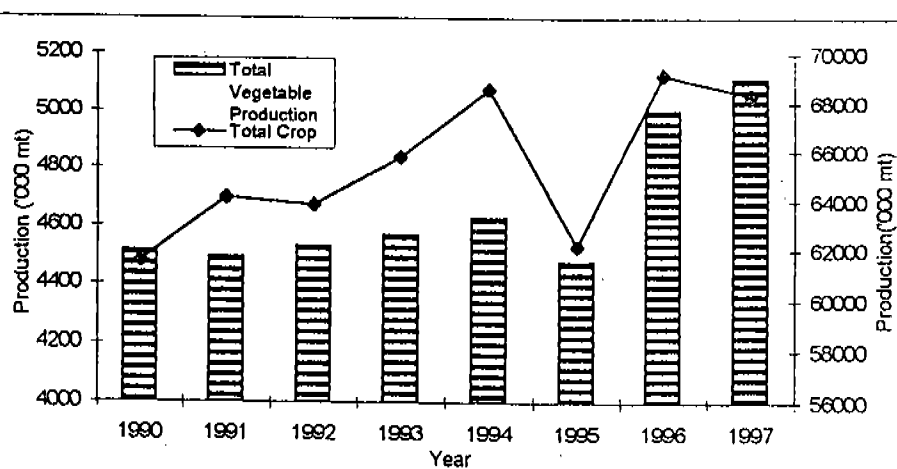


Figure 2. Total Vegetable and Agricultural Crop Production, Philippines, 1990-1997.

The total hectareage planted to vegetables comprised only 5 % of the total area cultivated to agricultural crops in the Philippines in 1997(Appendix Table 1). For the past eight years, hectareage devoted to vegetables grew only by 0.8 % annually from 594,000 hectares in 1990 to 625,500 hectares in 1997 as shown in Figure 1 due to a rapid conversion of prime lands into subdivisions and industrial park in some vegetable production areas like Benguet, Cavite, Batangas, and Laguna. In other areas, a series of calamities reduced the farm size allocated for vegetable production. The vegetable sector contributed P26 billion equivalent to 9.4% of the total value of agricultural crops grown in the country in 1997(Table 2).

Among the vegetables cultivated in the Philippines, asparagus registered the fastest growth in production (31.6%) and hectareage (27.5%) for the period 1990-1997(Table 1). The level of production surged to 10,990 mt in 1997 from a meager 1,910 mt eight years ago. The entry of a number of key players who ventured in the production and marketing of asparagus led to a sharp increase in production and area harvested in the 1990s. Tropi fresh alone expanded its area five times larger than its size since it entered the asparagus business. South Cotabato in Southern Mindanao remained as the main supplier of asparagus in 1997.

Eggplant ranked second with its production rising by 8.6 % annually from 112,700 mt in 1990 to 195,000 mt in 1997 (Table 1). Cagayan Valley accounted for the bulk of eggplant production (31%) in 1997, followed by Ilocos (25%) and Southern Tagalog(12%) as shown in Table 3.

The area planted to eggplant likewise increased by 2.4 % per annum from 16,400 hectares in 1990 to 19,000 hectares in 1997. The productivity of eggplant farms also improved over the period under study. Yield went up by 6.3 % annually from 6.9 mt per hectare in 1990 to 10.3 mt per hectare in 1997.

Inspite of a decline in yield, onion and garlic production grew annually at 5.3 % and 3.2%, respectively from 1990 to 1997(Table 1). The additional land allocated for the production of these crops offset the reduction in yields. Onion hectareage climbed by 9.9 % while the area planted for garlic rose by 5.0 % yearly. Onion production was highly concentrated in Central Luzon (59%) and Ilocos (38%). The major producing centers were Nueva Ecija, Ilocos Sur and Pangasinan. For garlic, the main producing region was Ilocos contributing 66% of total production. Trailing behind were Southern Tagalog (19%) and Central Luzon (8%).

Table 2. Value of Vegetable Production, Philippines, 1990-1997 (in Million Pesos)

Vegetable Types	1990	1991	1992	1993	1994	1995	1996	1997	Average Annual Growth Rate (%)
Tomato	833.5	928.5	793.9	786.6	1,090.6	713.7	762.8	1,038.0	6.1
Eggplant	688.6	638.6	663.5	789.3	897.6	982.9	1,414.0	1,557.9	13.3
Cabbage	538.2	557.1	638.1	984.8	834.4	967.1	702.2	787.1	8.2
Onion	497.5	604.8	530.2	536.6	1,083.1	1,001.9	1,443.1	1,128.7	18.1
Garlic	764.9	494.5	875.6	764.7	875.2	948.7	1,547.8	902.3	10.5
Mungbean	454.2	399.3	392.8	396.9	461.9	452.5	645.6	644.2	6.3
Fruit Bearing Vegetables	6,788.2	8,801.3	9,042.2	8,355.2	9,102.0	10,580.0	12,943.8	14,243.4	11.8
Leafy/Stem Vegetables	2,506.3	3,062.3	3,147.3	3,119.0	3,000.3	3,733.3	5,103.2	5,615.6	13.1
Total Vegetables	13,071.4	15,486.4	16,083.6	15,733.1	17,345.1	19,380.1	24,562.5	25,917.2	10.7
Total Agricultural Crops	153,925.1	164,311.5	172,710.3	177,472.0	199,327.2	230,396.2	270,015.0	276,826.1	8.9
% of Agri. Value of Prod.	8.5	9.4	9.3	8.9	8.7	8.4	9.1	9.4	

Source: Bureau of Agricultural Statistics

Table 3. Share of Leading Vegetable Producing Regions to the National Production, by Type of Vegetable, Philippines, 1997.

Vegetable Type/Region	Production (mt)	Share to Production (%)
Tomato		
Ilocos	50,351	30
Northern Mindanao	27,114	16
Central Luzon	20,956	13
Other Regions	67,942	41
Philippines	166,353	100
Eggplant		
Cagayan Valley	59,920	31
Ilocos	49,269	25
Southern Tagalog	23,189	12
Other Regions	62,654	32
Philippines	195,032	100
Cabbage		
CAR	63,545	66
Ilocos	6,631	7
Southern Tagalog	6,307	7
Other Regions	19,387	20
Philippines	95,870	100
Onion		
Central Luzon	50,546	59
Ilocos	32,765	38
Other Regions	2,072	2
Philippines	85,383	100
Garlic		
Ilocos	13,328	66
Southern Tagalog	3,852	19
Central Luzon	1,706	8
Other Regions	1,267	6
Philippines	20,153	100
Mungbean		
CAR	9,663	35
Northern Mindanao	3,845	14
Southern Mindanao	3,649	13
Other Regions	10,513	38
Philippines	27,670	100
Asparagus		
Southern Mindanao	10,920	99
Other Regions	68	1
Philippines	10,988	100

Source: Bureau of Agricultural Statistics

Tomato and cabbage exhibited a negative growth in production and area harvested in the 1990s. Tomato production and hectareage contracted at 1.1 % and 1.9 %, respectively from 1990-1997 (Table 1). Local production of cabbage also declined at 0.9 % and area by 0.3 % during the same period. The strong typhoons that hit the top producing areas in Luzon in the early and mid 1990s caused heavy damages on these vegetables. More than half of tomato production was supplied by Ilocos, Northern Mindanao and Central Luzon while close to 66 % of cabbage production was contributed by CAR, followed by Ilocos and Southern Tagalog, each with a 7 % production share in 1997 (Table 3). The main suppliers of tomato at the provincial level were Pangasinan, Ilocos Norte, Ilocos Sur, Bukidnon, Misamis Oriental, and Nueva Ecija. Leading production centers of highland cabbage were Benguet, Mt. Province, Cebu and Negros Oriental while lowland cabbage was mostly grown in Ilocos Sur.

Mungbean production slightly increased with <1% growth on a yearly basis owing to a minimal improvement in yield (0.6%) and a reduction in hectareage (-0.1%) for the period 1990-1997 (Table 1). CAR (35%), Northern Mindanao (14%) and Southern Mindanao (13%) were the key producers of mungbean during the same period (Table 3).

For other fruit bearing and leafy/stem vegetables (e.g. squash, gourds, okra, pechay, ampalaya, etc.), a positive growth in production of 1.5 % and 3.1 %, respectively was achieved as growers cultivated additional hectareage and gained better yield per hectare during the period 1990-1997 (Table 1).

2.2 Domestic Consumption

Vegetables add variety and flavor to a typical Filipino diet. The latest 1993 Food Consumption Survey done by FNRI-DOST shows that annual per capita consumption of vegetables reached 39 kg, accounting for 13.2 % of the total food intake (Table 4). It consisted of 11 kg of green leafy and yellow vegetables and 28 kg of other vegetables (Table 4). The most commonly eaten green leafy vegetables included "malunggay", "kangkong", sweet potato tops, "alugbati", pechay and gabi leaves. Squash and carrots were the highly preferred yellow or Vitamin A rich vegetables. Tomatoes, eggplant, cabbage, pechay, gourds, stringbeans, mungbean, onions, ampalaya, sayote and okra are among the most usual vegetable types in terms of quantities consumed.

Among regions, Cordillera Administrative Region, Cagayan Valley and Ilocos registered the highest vegetable consumption while Central and Western Visayas have the lowest intake (Table 5).

Table 4. Per Capita Vegetable Consumption, Philippines, 1993.

VEGETABLE GROUP	CONSUMPTION ¹ (kg/year)	PERCENT OF TOTAL FOOD INTAKE
Green Leafy and Yellow Vegetables	11	3.7
Other Vegetables	28	9.5
All Vegetables	39	13.2

¹Raw, as purchased

Source: FNRI-DOST

According to Villavieja (1998), the availability and affordability of specific vegetables, and the presence of ethnic and regional groups influence vegetable consumption pattern. The latter leads to the difference in consumer preferences and preparation techniques in many parts of the country. For instance, Ilocanos and Cagayanos of the north are noted for their vegetable dish with “bagoong” such as “pinakbet” and “dinengdeng”. The Tagalogs are well known for their vegetables sauteed or boiled as in “sinigang” or “nilaga”. At the Southern part of Luzon, Bicolanos prefer adding coconut milk and hot chili pepper to their vegetables like “laing” made up of dried “gabi” leaves. The Visayas are famous for preparing “tinola”, a dish of boiled fish and vegetables flavored with ginger. In Mindanao, some of the mentioned vegetable dishes are also available since a good number of households are migrants of Luzon and Visayas who decided to settle in the island.

Variations in vegetable consumption are also evident among different households classified by sector and income level. Rural households consumed 41 kg per capita per year, about 14 % higher than their urban counterparts (Table 6). Presumably, the availability of cheaper quality vegetables in the rural areas particularly in the farming sector partly explains the difference in vegetable consumption.

The level of income directly affects consumption of vegetables. While the per capita consumption for green leafy and yellow vegetables generally declines as per capita income improves, the actual intake of other vegetables increases with income. For all vegetable types, the high-income households consumed 42 kg per capita per year, about 14 % more than the low-income group (Table 7).

Table 5. Per Capita Vegetable Consumption by Region, Philippines, 1993.

REGION	CONSUMPTION (Kg/year)		
	Green And Yellow Vegetables	Other Vegetables	All Vegetables
NCR	7	25	32
Ilocos	15	48	63
CAR	14	51	65
Cagayan Valley	14	50	64
Central Luzon	7	37	44
Southern Tagalog	8	31	39
Bicol	10	27	37
Western Visayas	13	16	29
Central Visayas	11	12	22
Eastern Visayas	6	15	22
CARAGA	10	23	33
Western Mindanao	18	25	43
Northern Mindanao	14	27	41
Southern Mindanao	17	26	45
Central Mindanao	19	25	43
ARMM	13	26	39
Philippines	11	28	39

Source: FNRI-DOST

Table 6. Per Capital Vegetable Consumption by Urbanization, Philippines, 1993.

VEGETABLE GROUP	PHILIPPINES	ALL URBAN (kg/year)	METRO MANILA	OTHER URBAN	RURAL
Green and Yellow Vegetables	11	9	7	10	12
Other Vegetables	28	27	25	27	29
All Vegetables	39	36	32	37	41

Source: FNRI-DOST

Table 7. Per Capita Vegetable Consumption by Annual Per Capita Income, Philippines, 1993.

ANNUAL PER CAPITA INCOME (In Pesos)	CONSUMPTION (Kg/year)		
	Green Leafy and Yellow Vegetables	Other Vegetables	All Vegetables
Less than 3,000	12	25	37
3,000-5,999	12	27	39
6,000-8,999	11	27	38
9,000-11,999	10	28	38
12,000-14,999	8	30	38
15,000-17,999	11	31	42
18,000 and above	8	34	42

Source: FNRI-DOST.

Although vegetable production has been increasing, consumption is still below the recommended yearly allowance set by the Food and Nutrition Research Institute (FNRI). Adequacy level for green leafy and yellow vegetables was only 33%, 77 % for other vegetables, and 56 % for all types of vegetables (Table 8). Adequate vegetable consumption would require: (1) a more efficient marketing and distribution system for vegetables to ensure greater supply at reasonable prices; (2) education for farmers, traders and consumers on the importance of increasing vegetable consumption; and (3) promotion of diversified cropping systems with vegetables as potential crops.

Compared to other Asian countries, the per capita vegetable consumption of 39 kg in the Philippines is still very low. Gloria (1990) cited that unlike in the Philippines, large quantities of vegetables are consumed annually in the following Asian counterparts: Thailand (60 kg), China (98 kg), Taiwan (122 kg), and Japan (137 kg).

Table 8. Actual and Recommended Per Capita Consumption of Vegetables, Philippines 1993.

VEGETABLE GROUP	CONSUMPTION (kg/year)		
	Actual	Recommended	Consumption vs. Recommended Allowance (%)
Green Leafy and Yellow Vegetables	11	33	33
Other Vegetables	28	36	78
All Vegetables	39	69	56

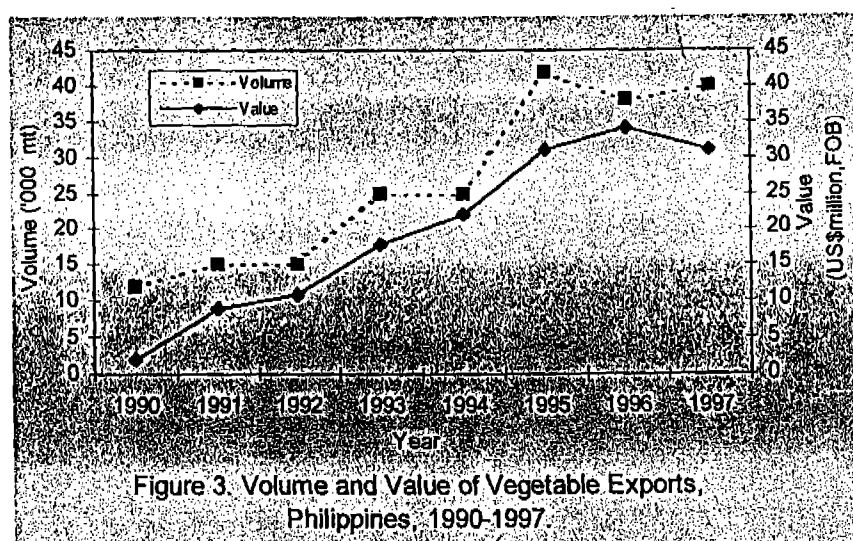
Source of basic data: FNRI-DOST.

2.3 External Trade

2.3.1 Exports

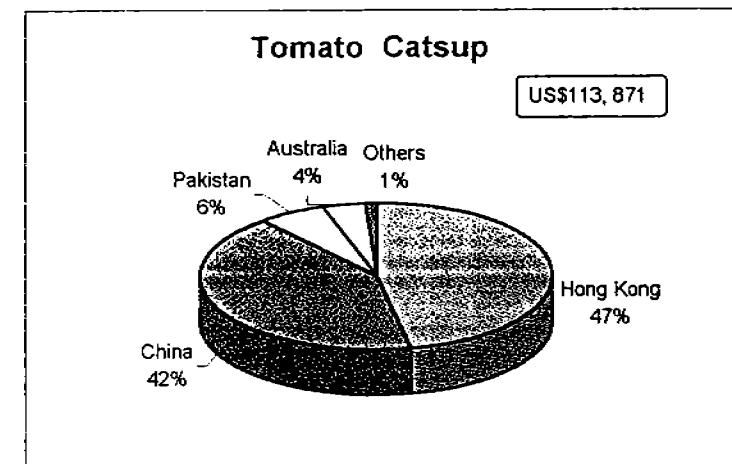
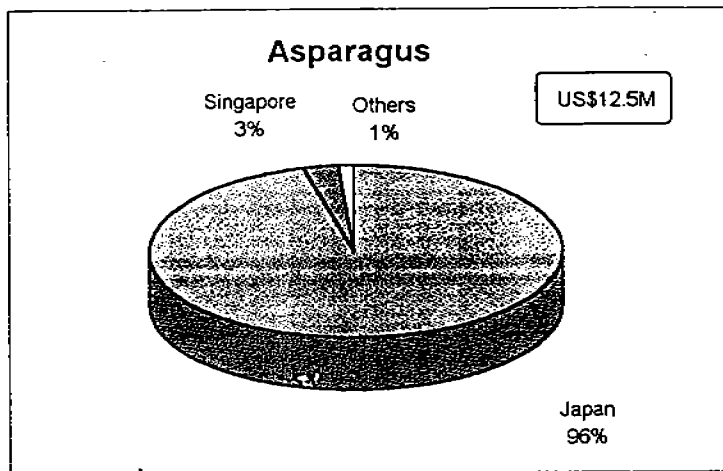
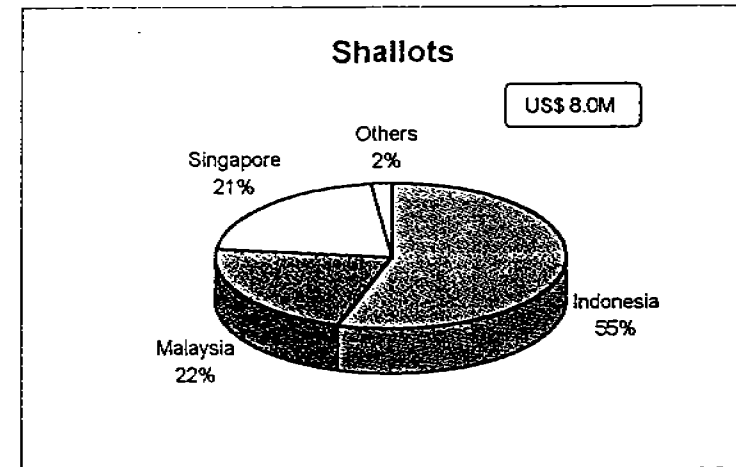
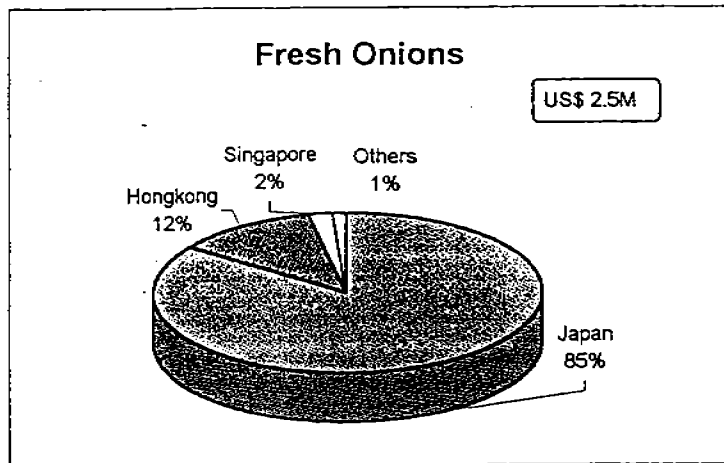
The Philippine vegetable exports followed an upward trend in terms of value from 1990 to 1996 before declining slightly in 1997. The value of vegetable exports grew at 71.4% from U.S.\$2 million in 1990 to U.S.\$31 million in 1997 (Figure 3). On quantity of exports, it slowly increased in the early 1990s then grew moderately in 1993 until it peaked in 1995. The volume of exports increased annually at 22.3% from 12,000 mt in 1990 to 40,000 mt in 1997. Total exports comprised of fresh/chilled vegetables, dried (beans and mungbean), semi-processed, pickled/dehydrated, prepared or preserved other than vinegar (frozen and unfrozen), cooked and uncooked, tomato paste, catsup, and juice.

In the vegetable export mix, onion traditionally has the biggest share; in 1997 it accounted for 34% of the industry's foreign exchange earnings. Exports of fresh onions (including shallots or native onion) reached 29,401mt, worth U.S.\$10.5 million. Japan got 85 % of the fresh onions, followed by Hong Kong (12%), Singapore (2%), and other countries (1%) such as Malaysia, Switzerland, United Kingdom and United States (Figure 4). Indonesia was the major buyer of shallots, absorbing 55% of the total; other major buyers included Malaysia (22%) and Singapore (21%). Dried onions although in minimal quantities (11.4mt) were also exported to Egypt.



Except for tomato catsup, exports of fresh and tomato-based products dwindled in the 1990s owing to high demand but insufficient supply in the domestic market. It accounted for barely 1 % of total vegetable exports. Fresh tomato exports declined remarkably from 21.4 mt in 1994 to only 777 kg in 1997 with Taiwan as the sole foreign buyer (Figure 4). In 1997, Hong Kong (50%) and China (40%) absorbed the bulk of tomato catsup exports (53.8 mt and 43.3mt,

Figure 4. Market Share of Different Countries Importing Fresh and Processed Vegetables from the Philippines by Form, 1997.

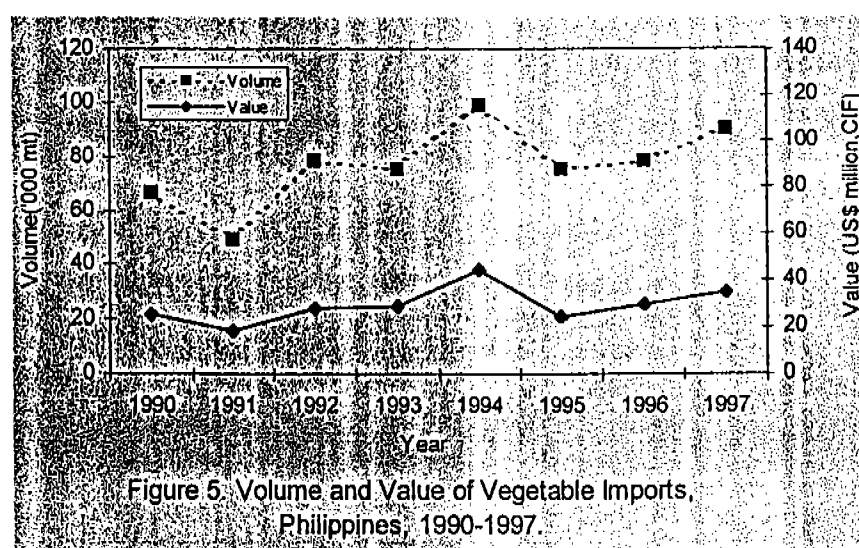


respectively); Pakistan (100%) for tomato juice (1.8mt); and Taiwan (40%) for tomato sauce (6.8mt).

Exports of asparagus are mostly in fresh /chilled form. Trading overseas began in the late 1980s with the entry of large agribusiness firms. The country's earnings escalated from a low U.S.\$79,400(43.6mt) in 1989 to a high of U.S.\$12.5 million (5,105mt) in 1997. With their penchant for health and energy foods, the Japanese especially preferred asparagus, absorbing 95 % of the exportable supply, while the rest was shipped to Singapore (3%), Hong Kong (1%), Korea (<1%) and Taiwan (<1%) as shown in Figure 4.

2.3.2 Imports

The country has been importing vegetables to augment local supply. Total imports rose from 66,000 mt(U.S.\$25 million) in 1990 to 90,000 mt(U.S.\$ 35 million) in 1997 posting an average annual growth rate of 8.1 % in eight years. Vegetable imports declined in 1991, then grew gradually and peaked in 1994. Between 1995 and 1997, it showed an increasing trend both in quantity and value of imports (Figure 5). Mungbean accounted for the largest chunk (30%) of total volume of vegetable imports in 1997, followed by green peas or chicharo(22%), tomato(17%), and garlic(6%).



Mungbean imports during 1991-1997 were on the upswing at a rate of 33.01 % per year with a high average annual expenditure of around U.S.\$6.6 million (18,912mt) as presented in Table 9. It was mostly in the form of dried mungbean (80%) while sotanghon accounted for the remaining 20 %. This upward trend was caused by an increase in the utilization of mungbean especially in the production of "hopia" and "togue", among others, as well as the commodity's

popularity among households and institutional buyers as a cheap protein-rich substitute for meat. Burma (26%), Australia (25%), and Indonesia (13%) were the important suppliers of mungbean collectively accounting for nearly two-thirds of the total imports in 1997 (Figure 6).

Table 9. Quantity and Value of Philippine Mungbean Imports by Product Form, 1991-1997.

YEAR	QUANTITY (mt)	VALUE ('000 US\$CIF)
1991	11,335	2,390
1992	14,331	4,773
1993	6,963	2,631
1994	20,243	6,524
1995	24,232	6,545
1996	28,140	12,153
1997	27,140	11,070
Average	18,912	6,584
Average Annual Growth Rate	33	47

Source: National Statistics Office

Green peas or "chicharo" were also imported by the country to fill the shortage in supply. The highest importation occurred in 1997 with purchases of 17,802 mt valued at U.S.\$6.3 million (Table 10). More than 90% of the imported green peas came from United States (50%) and Canada (43%).

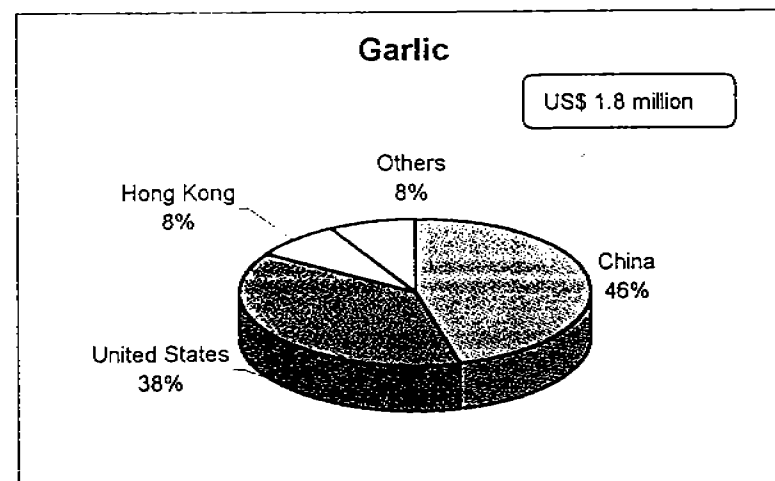
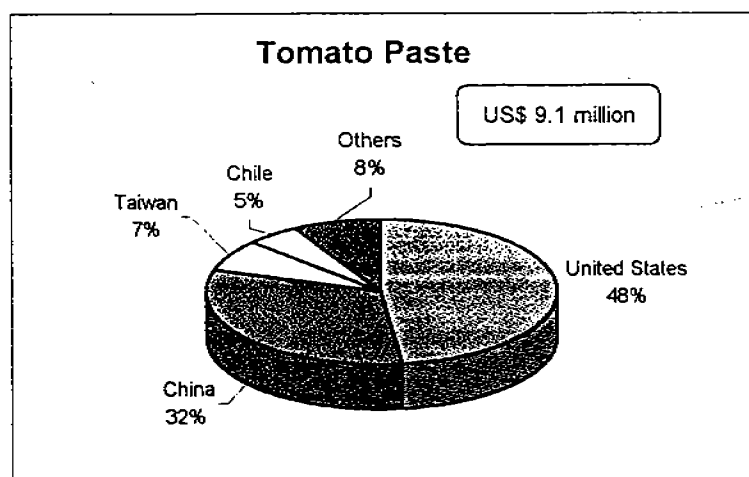
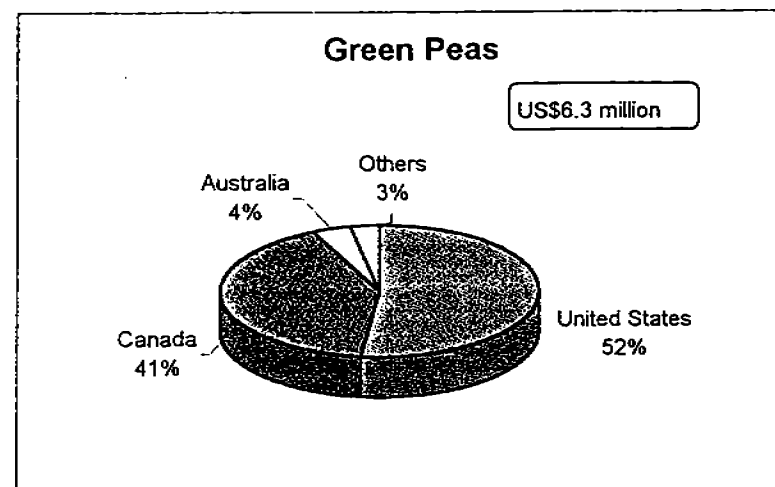
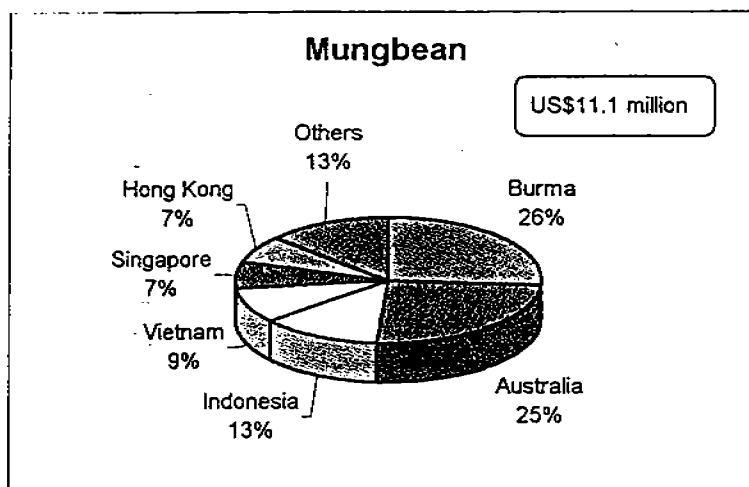
Tomato, both in fresh and processed form, is a high demand ingredient for various food preparations in the Filipino diet. The seasonality of fresh tomato supply and its limited local production lead to heavy imports.

Table 10. Quantity and Value of Philippine Green Peas Imports, 1991-1997.

YEAR	QUANTITY (mt)	VALUE ('000 US\$FOB)
1993	12,977	3,164
1994	12,545	2,765
1995	17,364	4,142
1996	12,966	3,663
1997	17,802	6,315
Average	10,522	2,864
Average Annual Growth Rate	12	25

Source: National Statistics Office

Figure 6. Market Share of Different Countries Exporting Selected Vegetables to the Philippines, 1997.



For 1991-1997, tomato imports increased steadily showing an annual growth of 23% in volume and 17% in value (Table 11). Tomato products come in the form of paste/puree, juice, catsup, sauce, fresh and preserves. High volume and value of imports were made in 1994 at 11,859 mt (U.S.\$8.6 million), but reduced purchases significantly in 1995 due to additional supply contributed by a new tomato processing firm in Northern Mindanao. Two years later, the country reverted back to its position as a heavy importer of tomato-based product specially tomato paste as a result of a temporary closure of the said processing plant. In 1977, tomato imports reached 15,063 mt worth U.S.\$9.5 million.

Garlic importation comprised of dried, whole, cut/sliced and broken/in powder form. From 1993 to 1997, garlic imports increased significantly from 471.8mt (U.S.\$805,029) to 1,276mt (U.S.\$1.8 million). Bulk of imports was sourced from China (46%) and United States (38%) as presented in Figure 6.

2.4 Problems/Constraints Affecting the Vegetable Industry

2.4.1 Production-Related

The major problems and constraints perceived by vegetable growers as most pressing and adversely affecting their operations are as follows: (1) high incidence of pests and diseases; (2) insufficient supply of good quality seeds; (3) high costs of inputs; (4) limited access to credit; (5) inadequate irrigation facilities; and (6) poor farm-to-market roads.

Vegetable growers in Benguet, Pangasinan, Nueva Ecija, Iloilo, and Misamis Oriental claim that high incidence of pests and diseases results in high cost of production and low productivity. The high incidence of pests and diseases for vegetables could be attributed to three factors: (1) growers' limited practice of basic cultural operations such as soil and seed sterilization, pests and disease control, weeding and rouging; (2) inadequate knowledge on varietal selection; and (3) limited interaction of farmers with public and private institutions tasked to provide updated technical information pertaining to proper cultural practices, varieties suitable to existing agro-climatic conditions, and improved technologies (i.e. organic farming and biological control of pests and diseases).

The insufficient supply of good quality seeds is the second problem facing the vegetable growers. They resort to repeated use of plant seeds saved and stored from previous harvests or purchased from traders in nearby public market. The continuous use of the same seeds leads to low productivity, poor quality harvest (i.e. shriveled, undeveloped, and small-sized), and high plant mortality. Reduction in seed quality is attributed to cross pollination, degeneration and accumulation of seed-borne pathogens.

Table 11. Quantity and Value of Philippine Tomato Imports, by Product Form, 1991-1997.

PRODUCT FORM	1991	1992	1993	1994	1995	1996	1997	Average Annual Growth Rate (%)
Quantity (mt)								
Fresh/Chilled	1	1	2	1	a	1	43	736
Tomato Paste	5,157	6,709	9,690	11,656	7,758	10,856	13,828	21
Preserved/Prepared	39	100	84	99	80	263	449	73
Tomato Catsup	57	71	40	59	98	182	480	57
Tomato Sauce	7	25	52	17	90	118	192	137
Tomato Juice	32	55	44	27	43	43	71	23
Total	5,293	6,961	9,912	11,859	8,069	11,463	15,063	23
Value('000US\$CIF)								
Fresh/Chilled	4	2	5	5	3	4	88	366
Tomato Paste	4,159	5,531	7,602	8,266	6,491	9,172	9,132	16
Preserved/Prepared	13	104	96	74	84	200	38	123
Tomato Catsup	17	23	45	92	153	222	145	52
Tomato Sauce	2	7	57	29	82	114	24	176
Tomato Juice	26	43	53	107	106	81	44	20
Total	4,221	5,710	7,858	8,573	6,916	9,793	9,471	17

Source: National Statistics Office

High cost of inputs is the third most critical problem in vegetable production. FRLD(1995) reported that in case of mungbean, 40% of production cost was accounted for by input supplies such as seeds, insecticides and fertilizers. The prices of planting materials usually double during lean production months from October to December. With growers having limited knowledge on using integrated pest management, they rely heavily on chemicals to eradicate pests and diseases.

Vegetable growers have expressed their desire for financial institutions to make credit available to them for the purchase of inputs. Limited access to credit has forced the farmers to rely on informal sources of credit such as traders and input suppliers who charge exorbitant interest rates(20-24%/cropping season), thus further reducing the growers' return.

The inadequate irrigation facilities is also another major concern of vegetable growers. They claim that after vegetable harvests in summer, their production areas remain idle until rainy season comes in July and August. In the absence of regular sources of water during the dry season, farmers could not cultivate second cropping using short-maturing varieties like mungbean. Growers are also prevented from timing their harvests during lean production months when prices of vegetables are quite high.

The problem of poor roads leading to the major artery of La Trinidad and Baguio City adversely affects the movement of vegetables grown in Benguet. These roads become extremely difficult to traverse during the rainy season. As a result, transporters charge high fees to cover maintenance expenses, further decreasing the profit- margin of producers. The same situation exists in Laguna, Quezon, Nueva Vizcaya, Negros, Cebu, Davao, Cotabato and Zambales.

In Bukidnon, Laguna and Quezon growers are compelled to pay high transport fees to haulers who use horses and cattle to carry vegetables due to lack of feeder roads. Such additional hauling fees further increase the transportation costs and reduces growers' net returns.

2.4.2 Marketing

The most common problems encountered in marketing vegetables are: (1) limited supply and inconsistent quality of vegetables; (2) inadequate storage facilities; (3) inefficient port services/facilities; and (4) limited access to reliable market information.

Trader-wholesalers based in key demand centers in the country find difficulties in sourcing vegetables (e.g. mungbean, tomato) during the second half of the year (July-December). Vegetable production in Luzon and Visayas starts in

late December and reaches its peak in February and March, while in Mindanao, large production occurs from March to May. In addition, (FRLD 1995) revealed that Metro Manila-based wholesalers (Balintawak and Divisoria) complained about the rampant practice of including poor quality tomatoes (blemished, small sizes, shriveled and overripe) in bulk deliveries supplied by growers. This practice resulted in high rates of unsaleable rejects.

Inadequate storage facilities is another problem encountered by traders particularly during the peak production months. It is further aggravated by lack of technical-know-how on proper handling, packaging and control of storage pests and diseases (e.g. seed weevil and molds in case of mungbean). For tomato wholesalers, cold storage is necessary to attain uniform ripening and prolong the shelf-life of the crop.

Assembler-wholesalers or "viajeros" from the demand centers of the Visayas and Mindanao regions (Cagayan de Oro City, Cebu City, Davao City) who supply and source vegetables from Metro Manila express dissatisfaction on the existing port services offered by both public and private groups. These traders complain of delays in arrival, pilferages, miscellaneous expenses, and inefficient handling of cargoes as major causes of postharvest losses. Aside from these issues, trader-wholesalers and marketing cooperatives from Cagayan de Oro which supply off-season to Luzon and Visayas raise the problem of limited container vans to accommodate their shipment especially during the peak demand period from August to December. These inefficiencies usually lead to delayed deliveries and high rates of unsaleable rejects.

Key players in the vegetable industry experience limited access to reliable and accurate market information pertaining to production statistics, quality requirements, preferred varieties, seasonality of production, prices at various market levels and supply and demand situation in the domestic and export markets.

Vegetable growers express the need to be informed on variety and quality standards required by traders and end-users such as households and institutional buyers (hotels and fastfood chains/restaurants). Unavailability of such information keeps them to cling on traditional varieties such as "1833" and "pedada" for tomatoes, thus limiting also the market possibilities for them.

Vegetable producers in Benguet, Pangasinan, Iloilo and Davao del Sur are highly dependent on traders as their main source of information. There are cases when they receive information from traders about the buying price two weeks after the deal is made. They only get minimal returns from the transactions.

Garlic importation comprised of dried, whole, cut/sliced and broken/in powder form. From 1993 to 1997, garlic imports increased significantly from 471.8 mt (U.S.\$ 805,029) to 1,267 mt (U.S.\$ 1.82 million). Bulk of imports was sourced from China (46%) and United States (38%) as presented in Figure 6.

2.5 Market Prospects

Recent developments in the domestic and export markets open opportunities for vegetables. Today, local consumers are more health conscious. Demand for organically grown crops has thus risen. Increasing urbanization, employment, and change in life style of more women would likely create a high demand for packed, frozen, and canned vegetables in the next millennium.

The rising number of fast food chains serving salads, hamburgers, pizzas and spaghetti creates high demand for selected vegetables such as lettuce, tomato, bell pepper, onion, and mushroom among others. The establishment of oriental restaurants leads to the increasing demand for mungbean products like "togue" and "sotanghon" in the preparation of an array of dishes (e.g. "sukiyaki", "shrimp, and "togue" patties, etc.), appetisers (e.g. "togue") and snackfoods (sauteed "sotanghon", spring rolls, etc.). The entry of more bakeries since the late 1980s which specialized on "hopia" (mungbean pastry), and initial efforts by a government agency to manufacture a mungbean-based baby food as well as its affordability as a main viand in place of meat in times of economic difficulties have likewise caused the uptrend in the local demand.

Processed vegetables have export potential, which the country could take advantage of if some improvements in the packaging technologies and standardization of products could be achieved.

A study on GATT's impact on the vegetable sector reveals that asparagus, okra and baby corn are competitive in the export market. Broccoli, melon and cauliflower are vegetables that are competitive as import substitutes (Bacani 1995).

Importation of tomato paste and "sotanghon" will continue in the future due to limited supply of processed tomato and mungbean. The "sotanghon" industry in the Philippines has gradually dwindled because it could hardly compete with the imported brands. Based on 1995 prices, second class local vermicelli (quality of which is comparable to the latter) costs about P60/kg while those sourced abroad have a landed price of about P40.60/kg (FRLD 1995).

At the domestic level, table tomato has been projected to create a surplus in major producing provinces (FRLD 1995). Producers of table tomatoes in Pangasinan and Nueva Ecija will continue to supply Metro Manila. Other areas in Luzon which can be tapped as alternative markets include: Laguna, Batangas, Cavite, Benguet, Pampanga and Bulacan. Iloilo and Negros Occidental tomato growers, on the other hand, will consider the different trading centers of Panay Island and Cebu as their market destinations because these demand areas will incur substantial deficit in supply, in contrast to the rapidly increasing local demand. Misamis Oriental will likewise remain as one of the major suppliers of off-season (June-November) tomatoes for Metro Manila given the favorable climatic condition to produce the crop all year round. Other areas that can be tapped as alternative outlets include the progressive cities of Cebu, Bacolod, Dumaguete, Tacloban, Dipolog and Butuan, among others.

In the short-run, an increase in the cultivation and production of appropriate and high-yielding processing tomato varieties would greatly benefit local manufacturers of tomato paste in terms of greater supply of raw materials leading to more continuous processing operations. Although the quality of Philippine tomato paste is comparable with imported ones, domestic producers have yet to concentrate on increasing their production output to be able to supply the substantial requirements of the local market before export trading of this commodity can be fully explored (FRLD 1995).

3.0 STATUS OF VEGETABLE R & D

3.1 Profile of the National Research System for Vegetables

The Philippine National Agriculture and Research System (NARS) is composed of two basic structures: (1) PCARRD as the planning and coordinating body, and (2) the national agriculture and resources R&D network (NARRDN)¹, a constellation of research centers and stations. The NARRDN members are line agencies (DA, DENR, and LGUs) and R&D institutions (state colleges and universities), and the private sector.

PCARRD today provides central leadership in the national agriculture research system which includes environment and natural resources. Its mandate covers formulation of plans and policies; establishing a system of priorities; developing a national R&D program; establishing and managing a network of centers of excellence for agriculture and natural resources (ANR); providing mechanism for coordination and assessment; and maintaining a repository of research information.

The basic units of this network are the 221 institutions comprising the 14 regional R&D consortia, which were established to build up regional capability for research management (Table 12). Once admitted as a member of the national research system, the agency is expected to align its current research thrusts with national research priorities. Private research institutions become members of the NARS and avail of grants-in-aid provided their research projects are attuned to priority research areas and results are made available to the public.

Table 12. The Regional Consortia, their Base Agencies and Membership, 1999.

REGION	CONSORTIUM	BASE AGENCY	MEMBERS
CAR	HARRDEC	BSU	16
1	ILARRDEC	MMSU	13
2	CVARRD	ISU	13
3	CLARRDEC	CLSU	17
4	STARRDEC	UPLB	14
5	BICARRD	CSSAC	15
6	WESVARRDEC	DA Reg. VI	26
7	CV-CIRRD	DA Reg. VII	11
8	VICARP	VISCA	20
9	WESMARRDEC	PCA Reg. IX	15
10	NOMCARD	CMU	14
11	SMARRDEC	DA Reg. XI	19
12	CEMARRDEC	USM	18
13	C-CARRD	DOST Reg. XIII	10

Source: PCARRD, 1999

¹ Composed of 4 national multi-commodity R&D centers; 7 national single-commodity R&D centers; 20 regional R&D centers; 88 cooperating stations; and 9 specialized agencies.

The national research centers have been selected not only on the basis of the strength of their existing facilities, strategic location and availability of research expertise, but also on the basis of their potential capabilities.

A national research center, whether multi-commodity or single commodity in scope, conducts basic and applied research across a broad range of disciplines. It packages generated technology appropriate for specific commodities and dominant farming or production systems after successful technology verification trials in regional and cooperating field stations.

A regional center concentrates on applied research on commodities of major importance to the region. The purpose is to provide more location-specific information needed within the various agro-ecological zones of the country. The regional research center verifies the output of national research centers and fine-tunes the packages of mature technologies to suit regional conditions.

Cooperating field stations are selected as experimental sites of state colleges and universities, the DA, and private organizations that provide facilities for on-farm/field trials.

Identified research centers and stations have specific responsibilities in conducting research at various levels for each commodity group. For vegetable crops, the network of research centers and experiment stations working under common R&D activities are listed in Tables 13 and 14. A total of 19 state colleges/universities are mandated to pursue vegetable research.

Table 13. R&D Network for Vegetables, Philippines, 1999.

NATIONAL RESPONSIBILITY	REGIONAL RESPONSIBILITY	COOPERATING AGENCIES
Luzon UPLB	Luzon BSU CLSU ISU MMSU Visayas VISCA Mindanao CMU USM	Luzon ASIST ESSC ISCA NVSIT PAC PSU QSC TCA WLU Visayas PSPC

Table 14. DA-based Vegetable R&D Centers and Stations.

COOPERATING STATIONS	RIARCs/ROSEs
<ul style="list-style-type: none"> • BPI-Baguio National Crop Research and Development Center • BPI-Los Baños National Crop Research and Development Center 	<ul style="list-style-type: none"> • DA-ILIARC Research and Outreach Station for Lowland Irrigated • Cagayan Valley Integrated Agric. Research Center • DA-CVIARC Research Outreach Station for Lowland Rainfed • Bicol Integrated Agric. Research Center • DA-BIARC Research Outreach Station for Upland Plain/Coastal and Marine Fisheries • Western Visayas Integrated Agric. Research Center • Central Visayas Integrated Agric. Research Center • DA-CENVIARC Research Outreach Station for Lowland Rainfed • Eastern Visayas Integrated Agricultural Research Center • DA-WESMIARC Research Outreach Station for Hillyland • DA-WESMIARC Research Outreach Station for Upland and Lowland • Northern Mindanao Integrated Agricultural Research Center • DA-SMIARC Research Outreach Station for Crops Development

Source: DA-BAR, 1998

Compared to other crops and research concerns, the University of the Philippines Los Banos (UPLB) is the major institution working on vegetable crop research at the national level. Within UPLB, three academic departments/units have been actively involved in various disciplines of vegetable research.

For one, crop improvement is a responsibility of the Institute of Plant Breeding (IPB). Crop protection is handled by the National Crop Protection Center (NCPC). Crop postharvest is a concern of the Postharvest Training and Research Center (PHTRC), while processing and utilization is the focus of the Institute of Food Science and Technology (IFST). Academic departments such as Horticulture and Agronomy of the College of Agriculture are preoccupied with generation of crop and seed production technologies. Crop physiology, which used to be a strong discipline is handled by Horticulture and IPB.

Regionwide, however, vegetable research receives attention from Benguet State University (BSU), Central Luzon State University (CLSU), Central Mindanao University (CMU), Isabela State University (ISU), Mariano Marcos State University (MMSU), and Visayas State College of Agriculture (VISCA), Central Mindanao University (CMU), and University of Southern Mindanao (USM).

At DA, the Bureau of Agricultural Research (BAR) integrates the department's research programs and activities and coordinates a hierarchy of research institutes, centers, and stations classified either as national or regional. These constitute DA's R&D system (DARDS) which is composed of attached bureaus, agencies and corporations that operate 46 national research centers/stations in various locations in the country.

The national commodity research centers provide national leadership in the planning and orchestration of the implementation, monitoring and evaluation of the research, development and extension (RDE) programs. These centers undertake basic and applied research and maintain a network of national, regional, and provincial collaborators in the RDE programs. In agriculture and natural resources, these would mean the same institutions (state colleges/universities) and therefore, the same scientists and research facilities.

At the regional level, there are 36 Regional Integrated Agricultural Research Centers (RIARCs). Under them, are 67 Research Outreach Stations (ROSEs), or an average of four per region. The ROSEs serve as satellite of the RIARCs and link between the regional and provincial RDE programs. They are tasked to undertake midstream and downstream-applied research, demonstrate technologies, serve as training facilities, and propagate genetic materials.

Vegetable research is a paramount concern of the RIARCs and ROSEs in nine regions (Table 14). In CAR, however, research for semi-temperate crops is handled by the BPI's Baguio National Crop Research and Development Center. In Region 4, the Los Banos National Crop Research and Development Center (LBNCRDC) takes the lead in vegetable crop research.

3.2 Funding, Manpower and Research Facilities

3.2.1 Funding

Resource allocations of research institutions come from direct budgetary support and project funds obtained from other government agencies, foreign donors, and in minimal amount, from the private sector. A review of public expenditures for R&D in agriculture and natural resources from 1992 to 1997 showed that about 75% of research allocations were direct budgetary support and 25%, project funds (David et al. 1998). Shares of project funds constituted 15% from local sources (government) and 10% from foreign donors.

Across institutions, fund ratio differed widely. In the case of PCARRD, in 1997 for example, 70.8 % came from direct support and 29.2 % from external grants by DOST. Figure 7 shows the trend and relationship of the allotment received by

PCARRD vis-à-vis the total resources generated from local and foreign donors from 1992 to 1997. In total, these were the figures administered by PCARRD, wherein nearly 60.0 % of which was distributed among members' agencies in the network. It should be noted however, that the Philippine NARS had generated financial assistance from other sources that were directly channelled to individual agencies and were not reflected here.

From 1990 to 1992, the aggressive efforts in resource generation account for high resources flowing into the system, particularly during the times when resources from foreign partners (i.e. USAID, FAO-UNDP, IDRC, AVRDC) came in generously. The downtrend of fund support from foreign donors from 1993 to 1996 reflects the dwindling resources for agriculture R&D in the world scenario brought about by global focus and priorities. Fortunately, a compensating shift to local resource generation was

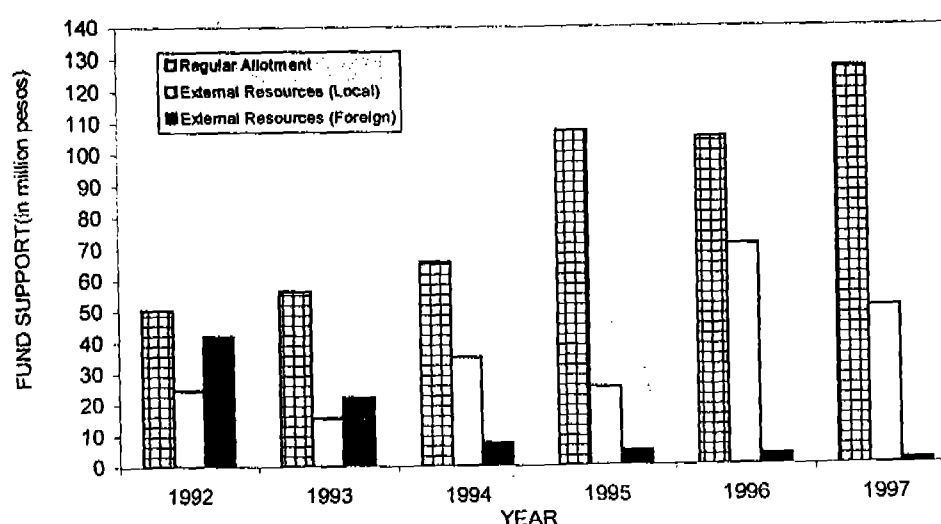


Figure 7. PCARRD's Regular Allotment vis-a-vis External Resources Generated, 1992-1997 (in million pesos).

adopted. The development of more local linkages and partners and the increasing support from DOST contributed to a sustained growth of local support for agricultural R&D.

DA for its part, got 52.0 % or the amount of P900 million from the national direct budgetary support for agricultural research in 1996 (Figure 8), an equivalent of 88.8 % share of the total R&D resources. Of this figure, P300 million was used to support the expenditures of the various RIARCs and ROSEs (Table 15). The rest of the amount was shared among DA staff bureaus (BAR, BPI, BAI, BSWM, and BPRE) and attached agencies (FIDA, NTA, PCA, PhilRice, SRA, PCC, NIA, NFA and CRDI).

Table 15. Distribution of DA's R&D Expenditures by Offices, 1992-1997 (in million pesos)

AGENCY	1992		1993		1994		1995		1996		1997	
	Reg. A lot.	Ext. Res.	Reg. A lot.	Ext. Res.	Reg. A lot.	Ext. Res.	Reg. A lot.	Ext. Res.	Reg. A lot.	Ext. Res.	Reg. A lot.	Ext. Res.
Regional Offices	211.50	22.76	192.80	11.32	225.47	16.72	257.34	10.92	286.22	18.17	na	na
Staff Bureaus												
BAR	10.79 ^a	-	11.37 ^a	-	14.68 ^a	-	17.18 ^a	-	18.55 ^a	-	na	na
BPI	17.40	-	17.40	-	32.97	-	33.02	-	44.27	-	47.57	-
BAI, BSWM, BPRE	50.39	1.58	36.87	30.90	46.41	11.32	51.59	16.84	60.61	19.52	85.24	40.44
Attached Agencies	179.36	7.05	214.42	9.38	336.78	11.25	405.22	49.78	513.19	68.03	532.20	(na)

^aFigures cannot be broken down into regular funds and external grants

na - not available

Source: David, C. C. et al. 1998

As a group, the SCUs had enjoyed a budgetary support of P215.9 million in 1997 and P368.1 million if external grants were included. Among SCUs, UPLB received the lion's share of the research budget granted in the same year. The amount could even equal or surpass that of the SCUs combined. On the average, CLSU, BSU and MMSU's budgetary support ranged from P6.0 million in 1992 to P15 million in 1997. Others had below P10 million (Table 16).

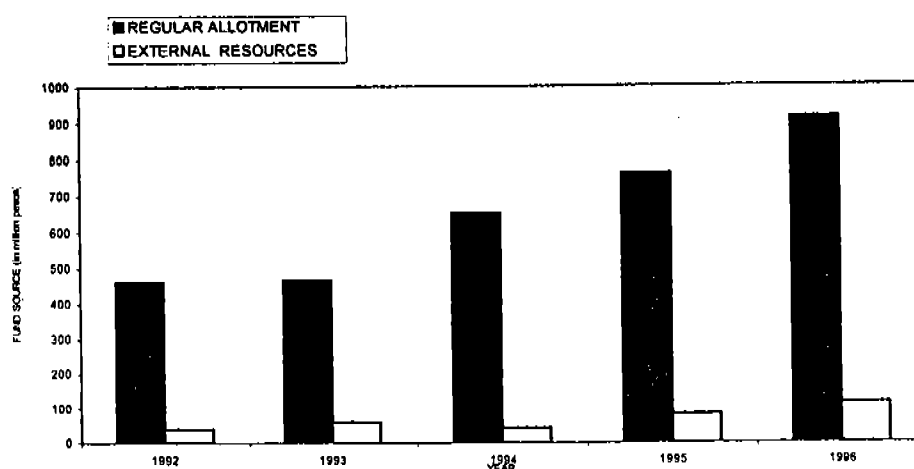


Figure 8. DA's Regular Allotment vis-a-vis External Resources Generated, 1992-1996 (in million pesos)

In terms of growth in budget support, the DA experienced the most rapid growth at an annual average of 20.17% from 1992-1996. PCARRD's research budget in total grew at slightly above 10% per year during the period 1992-1997. The trend is the same for SCUs, as research expenditures increased at about 10.26%.

The allocation of research budget across personnel services (PS), maintenance and operating expenses (MOE) and capital outlays (CO) affects the efficiency of agricultural research (David et al. 1998). DA's, expenditures for PS tended to be highest (56%) in all its regional offices, bureaus and attached agencies whereas, MOE was about 36 % and CO was only 8 % (Table 17). The opposite was noted in PCARRD where budget allocation for MOE (57%) was higher than its PS (41%) considering that the agency has fewer staff than DA. The same study found that in several multi-commodity or specialized agencies, PS expenditures reached as high as 70 to 80 %. One good example is UPLB where the share of PS is 71% (Table 18). Such disparity in funds for salary against operational budget was a result of the agencies' response to the Salary Standardization Law. In effect, disparity in budget proportion left research facilities underutilized and attracted external donors' support but primarily driven by their respective priorities.

Table 16. Public Expenditures* of Major State Colleges/Universities in Agriculture, 1992-1997 (In million pesos)

AGENCY	1992		1993		1994		1995		1996		1997	
	Reg. Allot.	Ext. Res.	Reg. Allot.	Ext. Res.	Reg. Allot.	Ext. Res.	Reg. Allot.	Ext. Res.	Reg. Allot.	Ext. Res.	Reg. Allot.	Ext. Res.
UPLB	87.32	74.25	90.69	105.78	76.73	142.03	108.88	141.79	123.89	99.30	120.36	103.86
VISCA	17.33*	11.09	19.93	9.77	19.25	7.05	19.54	8.45	23.81	7.50	24.18	9.61
CLSU	6.61*	1.96	10.64	2.69	12.18	2.39	14.21	7.64	14.64	2.45	17.49	5.35
BSU	5.69*	(na)	5.96	2.90	6.99	5.85	10.48	4.17	11.54	7.58	14.30	8.71
MMSU	6.77	(na)	8.17	3.01	6.49	5.62	10.01	4.97	12.19	8.08	13.50	14.02
USM	9.29	2.16	13.12	2.92	8.62	7.23	8.62	4.26	9.41	3.93	9.85	6.81
PSU	3.31*	(na)	3.36*	(na)	2.97	(na)	4.53	(na)	7.47	(na)	8.51	3.83
ISU	2.95	0.82	3.40	2.04	3.14	7.58	3.86	8.26	3.74	(na)	4.10	(na)
CMU	1.00	(na)	1.25	(na)	2.95	(na)	2.14	(na)	3.12	(na)	3.60	(na)
TOTAL	140.27	90.28	156.52	129.11	139.32	177.75	182.27	179.54	209.61	128.84	215.89	152.19
Ave. Growth Rate	230.55		285.63		317.07		361.81		338.45		368.08	
			23.89		11.01		14.11		-6.46		8.75	10.26

*Based on GAA, otherwise, it is the actual expenditure.

Note:

Figures in parenthesis include external grants.

na = not available

Source: David et.al. (1998)

Table 17. Distribution of Average (in %) Direct Budgetary Support for Agriculture R&D Across Agencies, 1994-1996.

AGENCY	PERSONNEL SERVICES	MAINTENANCE AND OPERATING EXPENSES	CAPITAL OUTLAY	TOTAL
PCARRD	41	57	2	100
DA	56	36	8	100
Reg. Offices	67	33	-	100
Bureaus	53	47	-	100
BAR	35	65	-	100
BPI	59	41	-	100
Attached Agencies	49	35	16	100

Source: PCARRD, DA

Table 18. Distribution of Average (in %) Direct Budgetary Support for Agriculture R&D Across SCUs, 1992-1996.

	PERSONNEL SERVICES	MAINTENANCE AND OPERATING EXPENSES	CAPITAL OUTLAY	TOTAL
SCU	64	36	-	100
BSU	91	9	-	100
CLSU	54	46	-	100
CMU	78	22	-	100
ISU	49	51	-	100
MMSU	65	35	-	100
PSU	88	9	3	100
UPLB	71	29	-	100
USM	9	91	-	100
VISCA	58	42	-	100

The relative economic importance of vegetables is indeed recognized by the NARS. Ranking as fourth and eighth, respectively, vegetables fall under Priority I² and share with other 13 priority commodities in the research budget of 80% allotted by PCARRD. Priority II³ gets 10%, whereas Priority III⁴, 3%. Data on actual allocation

² Include coconut and oil palm, corn and sorghum; fiber crops (cotton); legumes (soybean); plantation crops (coffee and cacao); rootcrops (sweet potato and cassava) sugarcane; vegetable crops (tomato and garlic); forage, pasture and grass; lands; carabeef; dipterocarp and lesser-used species; pines and other softwood species; mangrove and beach type forest; agroforestry and forest plantation; bamboo, rattan, forest vines, and other medicinal plants; and agricultural engineering.

³ Include fruit crops (pineapple and banana); rice, wheat and other cereal grains; tobacco; beef/shevon; molave type forests; farming systems; soil resources; water resources.

⁴ Include ornamental and medicinal plants; dairy; pork; poultry; parks, wildlife and forest range.

for vegetable research were not presented here, as PCARRD did not have corresponding budgetary allocation for a vegetable R&D program. Discussion on past researches would touch upon budget disbursed for vegetable research.

3.2.2 Manpower Resources

Complementing the financial capacity of the NARS is the availability and quality of the human resources. PCARRD initiated the institution of a set of minimum human resource requirement for the network members. For vegetable crop related fields, Table 19 outlines the minimum requirements for research personnel in national and regional R&D centers, and cooperating stations.

In a PCARRD-commissioned study in 1997, the Research Management Center (RMC) found that UPLB, as a national R&D center, more than met the minimum research personnel requirement. A total of 514 (MS and PhD combined) highly competent staff beef up UPLB's research manpower specialized in various fields (Table 20).

By specialization in crop research, UPLB has more experts in crop science, crop protection and plant breeding. At the PHTRC, 3 PhDs specialized in postharvest physiology and technology, biochemistry, and morpho-anatomy pursue vegetable research. IPB has 2 PhDs each in plant breeding, physiology, and entomology, and one each in plant pathology, genetic resources, and bio-chemistry. NCPC has 17 PhDs in the field of weed science, pesticide toxicology, agronomy, plant pathology, entomology, micro-biology, and chemical ecology, altogether.

Among other SCUs, VISCA has more on soil science while USM, on horticulture (Table 20). ISU is above the minimum requirement, but it lacks PhDs (3) and BS (16) personnel, although it seems to have more than sufficient number of researchers (Table 21). BSU needs 5 additional PhDs, though it has more than enough MS and BS degree holders. MMSU needs 2 each for PhD and MS, and 9 for BS degree holders.

Regional cooperating R&D agencies, such as BSU, ISU and MMSU did not meet the required number of PhDs. DA-BPI, which is heavily tasked to conduct vegetable research in almost all regions in the country, was found deficient in technical expertise for research (Table 21).

At the DA level, attached agencies have the most number of technical personnel (194), followed by the regional offices (142) with the PhDs and MS degree holders combined. DA attached agencies, staff bureaus and regional offices together have the most number of experts in agronomy (118), crop and soil sciences (both 45), entomology (31) and plant pathology (30) as indicated in Table 22. BPI, a staff bureau of DA mandated to carry out breeding and regional testing functions, requires 35 more PhDs and 13 MS holders. Its technical support staff of 105 (the difference from the 55

Table 19. Minimum Manpower Requirements for R&D Capability in Crops Research.

R & D CENTER/DISCIPLINE	MULTI-COMMODITY				SINGLE COMMODITY			
	PhD	MS	BS	Total	PhD	MS	BS	Total
A. National Research Center	8	11	11	30	7	10	10	27
Post Production or Seed Technology	2	3	3	8	2	3	3	8
Propagation/Production or Improvement or Plant Nutrition	2	3	3	8	2	3	3	8
Processing/Product Development	2	2	2	6	1	1	1	3
Crop Protection	2	3	3	8	2	3	3	8
B. Regional Research Center	6	3	3	12	1	3	3	7
Post Production or Seed Technology	2	1	1	4	1	1	1	3
Propagation/Production or Improvement or Plant Nutrition	2	1	1	4		1	1	2
Crop Protection	2	1	1	4		1	1	2
C. Cooperating Station	4	6	6	16		3	3	6
Post Production or Seed Technology	2	2	2	2		1	1	2
Propagation/Production or Improvement or Plant Nutrition	1	2	2	5		1	1	2
Crop Protection	1	2	2	5		1	1	2

Source: PCARRD, 1992

Table 20. Field of Specialization of PhD and MS Degree Technical Manpower in Crop Research in Selected SCUs, 1997.

AREA	LUZON												VISAYAS		MINDANAO			
	BSU		CLSU		ISU		MMSU		PSU		UPLB		VISCA		CMU		USM	
	MS	PhD	MS	PhD	MS	PhD	MS	PhD	MS	PhD	MS	PhD	MS	PhD	MS	PhD	MS	PhD
Agronomy	5	2	3	1	11	-	9	2	4	2	19	4	8	4	4		10	6
Crop Science	1	1	3	10	12	3	2	1	2	-	8	30	3	6	1	3	2	2
Entomology	2	1	1	1	-	12	2	2	1	-	14	27	3	4	3	1	3	1
General Agriculture	-	-	-	-	4	1	-	-	-	-	-	-	-	-	1	-	-	-
Crop Protection	-	-	-	-	-	-	1	-	-	3	11	-	-	-	-	-	-	-
Horticulture	5	10	1	1	1	-	3	-	-	-	15	3	2	1	-	1	16	2
Plant Breeding/Genetics	1	2	1	1	-	-	-	2	-	-	11	29	5	7	2	2	5	1
Plant Pathology	4	4	6	3	3	2	3	-	-	-	13	24	3	4	5	2	7	2
Postharvest	-	-	-	-	-	-	-	-	-	-	1	5	2	3	-	-	-	-
Soil Science	6	1	7	3	-	3	1	2	3	1	15	19	7	9	5	2	3	3
Seed Technology	-	-	-	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-
Weed Science	-	-	1	2	-	-	-	-	-	-	3	4	2	1	1	-	-	-
Food Science	1	-	-	3	-	-	3	-	1	-	10	20	2	6	-	1	-	-
Nutrition	-	-	-	-	-	-	-	-	1	-	9	3	-	-	1	-	1	-
Agri. Economics	1	1	4	2	4	2	1	-	2	-	20	18	4	3	5	2	5	2
Resource Economics	-	-	-	-	1	-	-	-	-	-	-	7	1		1			
General Economics	5	-	1	-	-	-	-	1	2	-	9	4		1	2			
Agribusiness	-	-	3	-	3	-	2	-	-	-	5		4		1		2	
Environmental Science	1	-	-	-	2	-	2	-	1	-	3	6	1			1	2	
Home Economics	-	-	-	-	-	-	1	-	-	1	5	2					1	1
Social Science	1	3	1	-	2	1	3	-	4	4	24	12	1	1				
TOTAL	33	25	32	27	43	24	33	10	21	11	297	217	48	50	33	15	57	20

Source: David, et al. (1998)

Table 21. Profile of R&D Personnel in Selected National and Regional Centers and Cooperating Stations in Agriculture and Natural Resources, 1997.

EDUCATION	NATIONAL R&D CENTER	REGIONAL R&D CENTERS						COOPERATING STATIONS
	UPLB	BSU	CMU	ISU	MMSU	USM	VISCA	DA-BPI
PhD								
Actual	53	15	43	17	18	37	39	5
(Required)	(45)	(20)	(20)	(20)	(20)	(17)	(8)	(40)
MS								
Actual	206	36	135	61	24	72	69	42
(Required)	(64)	(26)	(26)	(26)	(26)	(21)	(11)	(55)
BS								
Actual	225	36	139	13	20	8	24	160
(Required)	(74)	(29)	(29)	(29)	(29)	(22)	(11)	(55)
TOTAL								
Actual	484	87	317	91	62	117	132	207
(Required)	(183)	(75)	(75)	(75)	(75)	(60)	(30)	(150)

Source: RMC, UPLB, PCARRD, 1995-1997

Table 22. Field of Specialization of PhD & MS Holders in Crops Research, Department of Agriculture, 1997.

AREA	PhD				MS			
	Attached Agencies	Staff Bureaus	Regional Offices	Total	Attached Agencies	Staff Bureaus	Regional Offices	Total
Agronomy	5	3	1	9	47	13	58	118
Crop Science	2	-	-	2	13	3	29	45
Entomology	6	1	1	8	17	7	7	31
General Agriculture	-	-	-	-	3	-	-	3
Crop Protection	-	-	-	-	4	-	3	7
Horticulture	-	1	-	1	1	12	3	16
Plant Breeding/ Genetics	8	-	-	8	17	-	3	20
Plant Pathology	5	1	4	10	13	9	8	30
Postharvest	-	1	-	1	6	8	-	14
Seed Technology	1	-	-	1	-	-	-	2
Soil Science	6	4	1	11	19	15	11	45
Weed Science	-	-	-	-	-	-	1	1
Food Science	1	-	-	1	5	1	-	6
Nutrition	-	-	-	-	1	-	-	1
Agri. Economics	2	-	1	3	2	2	3	7
Resource Economics	-	-	-	-	-	-	1	1
General Economics	1	-	-	1	5	2	3	10
Agribusiness	-	-	-	-	-	2	2	4
Environmental Science	-	-	-	-	1	2	2	5
Social Science	-	-	-	-	3	4	-	7
TOTAL	37	11	8	56	157	80	134	373

minimum requirement of R&D personnel) are potential for upgrading. The DA research capacity needs further backstopping in seed technology, crop protection, food science and nutrition, economics and agribusiness.

Due to limitations of data and time constraint to gather such data for this research, the technical capacities of the LGUs (devolved extension workers) are not presented in this report.

3.2.3 Facilities

Critical to the operation of the R&D system, is its infrastructure capability. PCARRD also has set a minimum infrastructure requirements for the network members in their bid to sufficiently equip themselves with laboratories and research facilities essential in the conduct of research. The list of minimum requirements is published on a separate book series (BS No. 11/1993).

Result of the 1997 assessment of the national or regional R&D centers' research facilities showed that not even one met the standard provision of 144-sq.m. per researcher. Except IPB's, experimental fields are below the minimum standard; laboratory and communication equipment are inadequate; greenhouses and storage rooms need repairs.

3.2.4 Current Priorities for Vegetables

Under the DOST National Science and Technology Agenda (NSTA) 1999-2004, S&T development in the agriculture sector particularly crop research is anchored into enhanced productivity of vegetables together with fruits and rootcrops. In retrospect, under the DOST medium-term plan 2000, R&D intervention has been focused on vegetables as basic commodities along with rice, corn, rootcrops and sugarcane. In the medium-term, research would deal mainly on varietal improvement, biotechnology, and integrated pest management, soil and water management, postharvest handling, processing and seed production.

In the DA's KCCDP framework, vegetables for domestic consumption like tomato, highland vegetables, garlic, onion and mungbean have been identified as priority commodities that need strengthening and realignment of policy support, and require minimum infrastructure or resource investment to sustain their development.

In the NARS, prioritization of vegetable research from 1990-98 at national and regional levels was focused on indigenous and salad type vegetables (Table 23). Mungbean studies had been conducted in 9 regions; garlic in 5 regions; and onion in 4 regions. While pronouncement to conduct research on vegetables with export potential was made, vegetables identified were not considered as special concern of any particular region.

Table 23. National and Regional Priorities for Vegetable Commodities, 1990-1998.

NATIONAL PRIORITY COMMODITIES	REGIONS														
	CAR	1	2	3	4	5	6	7	8	9	10	11	12	13	ARMM
A. Basic															
Vegetable (salad type and indigenous)	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Garlic		x	x	x	x						x				
Onion (pungent)		x	x	x							x				
Mungbean		x	x	x	x		x	x	x	x			x		
B. Export															
Onion (sweet)															
Asparagus															
Okra															

Source: PCARRD, 1998

3.3 Review of Past and Ongoing Researches

3.3.1 Past Researches

From 1990 to 1998, a total of 612 studies were conducted on vegetables. Of this total, 489 were completed, while 105 are still continuing. Eighteen (or 2 %) were terminated due to the adverse effects of weather such as typhoons since these production and crop protection studies were conducted under field conditions (Table 24). Details of completed researches by commodity, area, and project activities are presented in Appendix Table 2.

The vegetable R&D emphasizes specific priority areas in response to the pressing needs of the industry. During this period, a total of 110 vegetable-related studies were completed on crop production, 125 on crop protection, 143 on crop improvement, and 61 on postharvest. Other areas such as seed technology (15), socio-economics and marketing (18) and extension (12). This indicates the clear flow of energies of research directed to production-oriented studies and less resources poured into post-production/crop processing, socio-economics and nutrition-related studies (Table 24). Across DA regional offices, regions 1, 4, 7, 3, and CAR were the most productive.

Of the total studies completed nation-wide, the DA with its regional offices (RIARCs and ROSEs), BPI and attached agencies, contributed 211 studies (Table 25). DA shared 77 studies (37%) on crop production, 51 studies (24%) on crop improvement, 46 studies (24%) on crop protection and pest management. On postharvest however, SCUs with the contribution of UPLB-PHTRC were found more capable in conducting this research discipline.

By type of vegetables, tomato received the most attention over other vegetables with 62 completed (Table 26). Tomato studies on crop production (16) were heavily concentrated on regional adaptability trials and yield and quality evaluation of processing types. Tomato breeding and crop improvement (17) attempts were focused on screening of tomato varieties for regional adaptability; characterization of newly developed varieties; development of lines with long shelf-life; application of *in-vitro* screening protocols on commercial cultivars; germplasm collection, evaluation maintenance of fresh and processing varieties; and breeding of rainy-season cultivar. Crop protection and pest management (16) activities were carried out on-farm trials for the crop's resistance and control against cercospora leaf mold, gray leaf spot, root-knot nematode, bacterial wilt, and other viruses.

Next to tomato was mungbean with 53 completed studies reported. Mungbean crop improvement studies (18) included development of improved varieties through germplasm collection, hybridization and selection; analysis for the detection of genetic polymorphism in important fungal pathogens of mungbean; and screening for shade-

Table 24. Number of Completed, Ongoing and Terminated Vegetable R&D Projects, Philippines.

RESEARCH AREA	COMPLETED	%	ONGOING	%	TERMINATED	%	TOTAL
Crop Production	110	22	14	13	10	56	134
Crop Improvement	143	29	40	38	-	-	183
Crop Protection and Pest Management	125	26	40	38	7	39	172
Postproduction and Crop Processing	61	12	4	4	-	-	65
Seed Technology and Production	15	3	4	4	1	6	20
Socio-Economics and Marketing	18	4	1	1	-	-	19
Extension	12	2	1	1	-	-	13
Others ¹	5	1	1	1	-	-	6
TOTAL	489	100	105	100	18	100	612

¹ included: Food and Nutrition and Integrated R & D

Source: PCARRD-RMIS, DA, UPLB-PHTRC

Table 25. Completed Number of Vegetable Research Conducted by Agency and Research Area, Philippines, 1990-1998.

AGENCY	RESEARCH AREA								Total
	Crop Production	Crop Improvement	Crop Protection and Pest Management	Postproduction and Crop Processing	Seed Technology and Production	Socio-Economics and Marketing	Extension	Others ¹	
DA Reg. Offices	41	29	25	2	4	8	6	1	116
1	14	3	3	2	3	3		1	29
2	2		1				1		4
3	6	2	3		1	1			13
4	4	9	2						15
5	3		3						6
6	3	1							4
7	1	3	4			2	1		11
8	1					1			2
9		1	2						3
10	1	1	1						3
11	4	3	3			1	1		12
CAR	2	6	3				3		14
DA	8	1	1	2	5	1	3		21
BPI	28	21	19		2	1		3	74
DOST		2							2
SCU's	32	87	68	57	4	8	3	1	260
BSU	2	8	7		1				18
BU	1								1
CLSU	1					1			2
CSSAC	1	2				1			4
DMMSU	2					1			3
DSAC	2	1		1					4
ISU		1	1		1				3
MMSU	5	5	4	1		1	1		17
NVSIT	1	2	1		1				5
PAC	2	1				1			4
PSPC	1	1							2
PSU	3						1		4
TCA				1					1
USM							1		1
UPLB-IPB	3	44	16		1				64
UPLB-NCPC			24						24
UPLB-PHTRC			1	51		2			54
OTHER UPLB UNITS	6	18	11	3		1		1	40
VISCA	2	4	3						9
IPGRI		3							3
UEP			1						1
DASMIARC									0
WESMIARC									0
BIARC									0
CVIARC									0
RFU-CLARC									0
NLUC-CAF			2						2
UNKNOWN	1		9						10
TOTAL	110	143	125	61	15	18	12	5	489
Percent	22	29	26	12	3	4	2	1	100

¹ Included Food and Nutrition (P 45,481) and Integrated R & D (P 1,335,000)

Table 26 . Number of Completed Vegetable R&D generated by Research Area and Commodity, Philippines, 1990-1999

COMMODITY	RESEARCH AREA								TOTAL
	Crop Production	Crop Improvement	Crop Protection and Pest Management	Postproduction and Crop Processing	Seed Technology and Production	Socio-Economics and Marketing	Extension	Others ¹	
Tomato	16	17	16	9	1	-	3	-	62
Eggplant	3	2	3	3	-	-	-	-	11
Cabbage	6	4	21	-	1	-	-	-	32
Onion/Shall	3	7	1	1	-	4	-	-	16
Garlic	7	7	3	5	1	-	-	-	23
Mungbean	13	18	10	-	3	7	1	1	53
Asparagus	8	6	1	1	-	2	-	-	18
Squash	5	1	-	1	-	-	-	-	7
Crucifers	5	5	12	3	2	-	-	-	27
Cucurbits	-	4	3	-	-	-	-	-	7
Carrots	2	2	-	-	1	-	-	-	5
Pepper	2	4	1	1	-	-	-	-	8
Sponge Gourd	3	4	-	-	-	-	-	-	7
Cauliflower	1	1	-	-	-	-	-	-	2
Broccoli	-	2	-	-	-	-	-	-	2
Ginger	-	-	-	1	-	-	-	-	1
Mushroom	-	8	-	-	-	-	-	-	8
Selected Veg.	14	22	18	28	2	1	3	2	90
Veg. In Gen	22	29	36	8	4	4	5	2	110
TOTAL	110	143	125	61	15	18	12	5	489

¹ Included Food and Nutrition (3) and Integrated R & D (2)

² Included combination of different vegetables, indigenous,

tolerant mungbean varieties. Crop production studies (13) were mostly on regional yield trials; and maintenance of seed breeder stock of seed board varieties.

Cabbage, with 32 studies completed, received substantial attention on crop protection and management (21). These studies were focused on the lack of crop's resistance against diamondback moth, a serious problem of all crucifers. It was reported in all growing areas that many pesticides had been ineffective in controlling it.

From 1990-1998, the total amount spent for vegetable research was about P74.3 million. This amount was very minimal, averaging only P8.3 million a year and accounting for only 0.04% of the total value of vegetable production from 1990-1997. Among the various vegetable research disciplines, breeding and crop improvement received the highest financial support of P30.7 million given the fact that it was the most researched area (based on the number of researchers conducted) from 1990 to 1998. Secondly, vegetable research support favored crop protection and pest management with P20.6 million, and followed by postproduction and crop processing with P10.4 million. Studies on seed technology, socio-economics, extension, and food and nutrition were least funded.

Of the total amount spent for vegetable research, P54.7 million (74%) was managed by SCUs, of which P43.3 million was taken by UPLB (Table 27). The DA regional offices, on the other hand, enjoyed a share of P6.2 million (8%), while BPI research stations, P4.4 million (6%).

Among specific crop commodities, cabbage had enjoyed substantial research support with P10.5 million disbursed for research with focus on IPM of diamondback moth (Table 28). Next to cabbage, vegetable research budget was proportionately high for tomato and mungbean with P6.8 million and P5.6 million, respectively. These three crops reflect the most visible contribution of AVRDC to local vegetable research in terms of financial support and supply of raw and improved germplasm of cabbage (*Brassica campestris*), tomato (*Lycopersicon esculentum*) and mungbean (*Vigna radiata*). The AVRDC Outreach Program based at BPI Los Baños, is exclusively devoted to testing AVRDC varieties and breeding lines.

Mungbean researches were on development of improved varieties through germplasm collection; introduction, evaluation, and selection of breeding lines; maintenance of breeder seed stock of seed board varieties; yield trials on intercropping of mungbean; detection and evaluation of important fungal pathogens on mungbean.

Selected and general vegetables, as another groups, seemingly both received high amount of financial support (P16.0 million and P22.4 million, respectively). However, vegetable types of these groupings cannot be specifically identified because studies had been conducted either in combination with other vegetable crops or vegetables in general.

Table 27. Completed Vegetable Research Budget by Agency and Research Area, Philippines, 1990-1998.

AGENCY	RESEARCH AREA								Total (P)
	Crop Production	Crop Improvement	Crop Protection and Pest Management	Postproduction and Crop Processing (P)	Seed Technology and Production	Socio- Economics and Marketing	Extension	Others ¹	
DA Reg. Offices	2,188,808	1,146,294	1,865,856	70,000	331,308	421,008	172,000	0	6,205,274
1	306,000	98,000	46,175	70,000	203,500	84,000	-	-	807,675
2	241,220	-	8,000	-	-	-	15,000	-	264,220
3	377,924	57,000	127,956	-	127,808	118,504	-	-	809,192
4	123,360	410,360	55,000	-	-	-	-	-	588,720
5	411,196	-	751,872	-	-	-	-	-	1,163,068
6	172,112	97,056	-	-	-	-	-	-	269,168
7	15,000	64,124	341,342	-	-	108,000	30,000	-	558,466
8	40,000	-	-	-	-	28,000	-	-	68,000
9	-	-	114,492	-	-	-	-	-	114,492
10	10,000	9,250	126,019	-	-	-	-	-	145,269
11	415,486	146,504	155,000	-	-	82,504	57,000	-	856,504
CAR	86,500	264,000	140,000	-	-	-	70,000	-	560,500
DA	199,156	133,100	78,774	790,171	119,019	58,590	318,282	1,335,000	3,032,092
BPI	1,049,025	2,420,704	670,936	-	154,000	29,556	-	45,481	4,369,702
DOST	-	959,803	-	-	-	-	-	-	959,803
SCU's	3,010,193	23,848,394	16,769,282	9,550,825	960,513	498,067	88,250	0	54,725,524
BSU	-	35,000	5,506,953	-	472,000	-	-	-	6,013,953
BU	103,600	-	-	-	-	-	-	-	103,600
CLSU	150,000	-	-	-	-	80,000	-	-	230,000
CSSAC	34,000	281,800	-	-	-	40,000	-	-	355,800
DMMSU	60,000	-	-	-	-	73,349	-	-	133,349
DSAC	305,000	75,000	-	100,000	-	-	-	-	480,000
ISU	-	94,808	83,032	-	109,581	-	-	-	287,421
MMSU	375,000	190,600	139,350	-	-	15,000	10,000	-	729,950
NVSIT	112,000	62,000	108,000	-	218,932	-	-	-	500,932
PAC	136,900	37,150	-	-	-	22,000	-	-	196,050
PSPC	18,000	24,000	-	-	-	-	-	-	42,000
PSU	20,200	-	-	-	-	-	7,000	-	27,200
TCA	-	-	-	113,550	-	-	-	-	113,550
USM	-	-	-	-	-	-	71,250	-	71,250
UPLB-IPB	710,750	15,558,676	3,570,719	-	160,000	-	-	-	20,000,145
UPLB-NCPC	-	-	1,245,969	-	-	-	-	-	1,245,969
UPLB-PHTRC	-	-	-	8,234,967	-	110,881	-	-	8,345,848
OTHER UPLB UNIT	567,366	6,465,438	5,412,207	1,102,308	-	156,837	-	-	13,704,156
VISCA	417,377	1,023,922	703,052	-	-	-	-	-	2,144,351
IPGRI	-	2,143,320	-	-	-	-	-	-	2,143,320
UEP	-	-	28,000	-	-	-	-	-	28,000
DASMIARC	-	-	-	-	-	-	-	-	0
BIARC	-	-	-	-	-	-	-	-	0
CVIARC	-	-	-	-	-	-	-	-	0
RFU-CLIARC	-	-	-	-	-	-	-	-	0
NLUC-CAF	-	-	131,300	-	-	-	-	-	131,300
UNKNOWN	1,600,000	-	1,061,446	-	-	-	-	-	2,661,446
TOTAL	8,067,182	30,651,615	20,605,594	10,410,996	1,564,840	1,007,221	578,532	1,380,481	74,256,461

¹Included Food and Nutrition (P 45,481) and Integrated R & D (P 1,335,000)

Table 28. Completed Vegetable Research Budget by Agency and Commodity, Philippines, 1990-1997.

Table 28. Completed Vegetable Research Budget by Agency and Commodity, Philippines, 1990-1997.																				
AGENCY	COMMODITY																			
	Eggplant	Tomato	Cabbage	Onion	Shallots	Garlic	Mungbean	Asparagus	Squash	Cucumbers	Cucurbits	Carrots	Pepper	Sp. Onion	Calliflower	Broccoli	Ginger	Mushroom	Salt Veg.	Gen. Veg.
DA Reg. Offices	40,000	574,014	350,519	45,000	218,500	1,182,232	381,020	181,040	80,000	18,000	84,500	109,000	0	37,000	0	0	0	781,271	1,769,382	5,819,478
1		82,000			203,500	182,000		44,000										204,675	81,500	807,875
2		15,000					181,220												60,000	256,220
3		57,000				624,236														681,236
4	25,000	15,000	59,000	15,000	15,000						15,000			37,000				350,360	57,360	588,720
5								137,040											945,528	1,082,568
6		87,056				60,000												112,112	268,168	268,168
7	15,000					108,000												64,124	276,902	464,026
8		40,000																	28,000	68,000
9																				0
10		8,250	126,019																125,062	260,361
11		228,708		30,000		207,996	199,800												85,000	751,504
CAR		30,000	165,500						80,000	16,000	69,500	109,000						20,000	100,000	590,000
DA		282,973	5,000	58,580	134,000	150,428			57,000		25,000	1,497,893				25,000		502,381	1,771,584	4,509,829
BPI	183,447	341,908	135,600	12,000	20,000	312,077	231,000	325,070	567,861	44,318	10,000		46,600					120,881	371,912	2,822,475
DOST																			959,803	959,803
SCU's	205,000	8,558,961	9,987,837	2,332,954	2,116,792	3,981,082	570,000	0	805,957	440,000	0	859,965	924,897	0	0	113,500	35,000	14,665,765	17,827,028	60,144,436
BSU			5,506,953																472,000	6,013,953
BU				80,000															103,600	103,600
CLSU																			150,000	230,000
CSSAC																			281,800	355,800
DMMSU						60,000	480,000												73,349	613,349
OSAC																				0
ISU						287,421														287,421
MMSU		200,000			40,000				20,000										120,000	349,950
NVSIT																			62,000	438,932
PAC							66,000												37,150	92,900
PSPC		18,000					24,000													42,000
PSU		7,000				7,000						13,200								27,200
TCA																	113,500			113,500
USM																				71,250
UPLB-IPB	195,000	4,736,485		1,737,792	1,667,792	2,879,168			275,000	390,000		856,665	791,697						2,682,801	5,734,845
UPLB-NCPC	10,000	128,440	333,776			202,829				50,000									565,364	1,340,409
UPLB-PHTRC		96,000		221,762	55,000														6,492,553	2,829,533
OTHER UPLB UNITS		159,536	3,416,781	283,400	316,000	305,408													3,570,976	3,993,855
VISCA			325,327										133,000						598,422	1,087,602
IPGRI																				2,142,320
UEP		26,000																		28,000
DASMIARC		105,000																		105,000
WESMIARC																				0
BIARC		80,500																		80,500
CENVIARC																				0
CVIARC						8,000														8,000
RFU-CLIARC				10,000		117,956														127,956
NLUC-CAF						131,300														131,300
UNKNOWN			405,000		30,000				510,957									110,000	45,489	1,101,446
TOTAL	428,447	6,757,856	10,478,956	2,446,544	2,489,292	6,635,819	1,182,020	806,110	1,610,818	500,319	119,500	2,476,758	971,297	37,000	25,000	113,900	35,000	16,040,078	22,399,707	74,256,821
Percent																				

From the total of 612 vegetable researches conducted in the laboratories and tested in the farmer's field, breeding and crop improvement had the biggest proportion by specific crops and financial support. This amplifies that vegetable crop improvement has gained stronghold through the years.

Among SCUs, UPLB, as the national research center, conducted substantial number of vegetable studies through the participation of graduate and undergraduate students. A total of 81 theses were conducted (14 graduate and 67 undergraduate) (Tables 29 and 30). Of the total undergraduate theses, 28 % dealt on market research, 22% on crop production, and 15% on crop protection and pest management. Fifty-three percent of the graduate dissertation touched upon postharvest. In the earlier discussion, it was observed that these areas were barely touched by SCUs. For UPLB, researches done by students with the guidance of competent faculty members could offset those areas that need immediate scientific inquiry under limited financial resources.

BPI made a significant contribution in vegetable research, with 74 researches conducted during the period under review. Of these studies, 28 were on crop production, 21 on crop improvement, and 19 on crop protection and pest management. Among BPI experiment stations, the BPI Los Baños National Crops Research and Development Center (Region 4) and BPI Baguio National Crops Research and Development Center were the most productive.

3.3.2 Ongoing Researches

Of the 612 vegetable studies conducted, 105 (17%) are ongoing, majority of which commenced in 1996 and 1997 and have been pursued as of this report. Again, these studies had been designed to address crop improvement and breeding (40), crop protection and pest management (40), and crop production (14) concerns (Table 31). Minor effort has been exerted on postharvest/processing, seed technology, socio-economics and marketing, extension, and food and nutrition.

By individual crops, there are 10 ongoing studies on tomato, majority of which are about crop improvement (Table 32). Three are demonstration trials of tomato lines conducted by DA, whereas three are screening and genetic improvement of the crop for resistance to major diseases spearheaded by UPLB-IPB. Of the 37 researches on selected vegetables, 19 are being pursued by UPLB, which are mostly genetic selection and characterization of mungbean, eggplant, sweet pepper and other vegetables; varietal improvement of traditional cucurbits such as watermelon, melon, and cucumber, onion, shallot and garlic. For crucifers, 7 studies out of the 9 ongoing, are focused on IPM of diamondback moth in heading cabbage, Chinese cabbage, and broccoli (Table 33).

Table 29. Number of Undergraduate and Graduate Thesis on Vegetables Conducted in UPLB, by Field of Study, 1990-1998.¹

FIELD OF STUDY	Undergraduate Thesis		Graduate Thesis/Dissertation	
	Number	%	Number	%
Crop Production	16	22	1	8
Varietal Improvement	8	11	1	8
Crop Protection and Pest Management	11	15	1	8
Postharvest	3	4	7	54
Crop Processing	6	8		
Seed Technology	2	3		
Marketing				
Market Research ²	20	27	2	15
Farm and Business Management	5	7	1	8
Policy/Program	2	3		
Total	73	100	13	100

¹ Data derived from Appendix

² Included industry profile.

Table 30. Number of Undergraduate and Graduate Thesis on Vegetables Conducted in UPLB, by College and Field of Study, 1990-1997¹.

FIELD OF STUDY	Undergraduate Thesis		Graduate Thesis/Dissertation	
	Number	%	Number	%
College of Agriculture				
Crop Production	12	31	1	10
Varietal Improvement	8	20	1	10
Crop Protection and Postharvest	11	28	1	10
Postharvest	1	3	7	70
Crop Processing	5	13	-	-
Seed Technology	2	5	-	-
Total	39	100	10	100
College of Economics and Management				
Crop Production	4	12	-	-
Crop Processing	1	3	-	-
Postharvest	2	6	-	-
Socio-Economics/Marketing/Policy				
Market Research ²	20	59	2	67
Farm and Business Management	5	15	1	33
Policy/Program	2	6		
Total	34	100	3	100

¹ Data derived from Appendix

² Included industry profile.

Table 31. Number of Ongoing Vegetable Research Conducted by Agency and Research Area, Philippines, 1990-1999.

AGENCY	RESEARCH AREA								Total
	Crop Production	Crop Improvement	Crop Protection and Pest Management	Postharvest	Seed Technology	Socio- Economics and Marketing	Extension	Others ¹	
DA Reg. Offices	1	1	0	0	1	1	0	0	4
1	1	-	-	-	1	-	-	-	2
11	-	1	-	-	-	-	-	-	1
CAR	-	-	-	-	-	1	-	-	1
DA	1	1	7	4	-	-	-	-	13
BPI	-	3	-	-	-	-	-	-	3
DOST	1	-	-	-	-	-	-	-	1
SCU's	11	35	29	0	3	0	0	1	79
BSU	5	3	2	-	1	-	-	1	12
DMMSU	3	1	-	-	-	-	-	-	4
MMSU	3	1	-	-	1	-	-	-	2
PSPC	1	-	-	-	-	-	-	-	1
UPLB-IPB	-	11	14	-	1	-	-	-	26
UPLB-NCPC	-	-	11	-	-	-	-	-	11
OTHER UPLB UNITS	1	20	2	-	-	-	-	-	23
WESMIARC	-	-	-	-	-	-	1	-	1
UNKNOWN	-	-	4	-	-	-	-	-	4
TOTAL	14	40	40	4	4	1	1	1	105
Percent	13	38	38	4	4	1	1	1	100

¹ Included Food and Nutrition only

Table 32 . Number of Ongoing Vegetable R & D generated by Research Area and Commodity, Philippines, 1990-199

COMMODITY	RESEARCH AREA								TOTAL
	Crop Production	Crop Improvement	Crop Protection and Pest Management	Postproduction and Crop Processing	Seed Technology and Production	Socio-Economics and Marketing	Extension	Others ¹	
Tomato	2	6	2	-	-	-	-	-	10
Cabbage	-	-	3	-	-	-	-	-	3
Onion	-	-	-	-	-	-	1	-	1
Garlic	1	-	-	-	-	-	-	-	1
Mungbean	-	2	1	-	-	-	-	-	3
Asparagus	3	-	1	-	-	-	-	-	4
Crucifers	-	2	7	-	-	-	-	-	9
Cucurbits	-	2	-	-	-	-	-	-	2
Carrots	2	3	-	-	-	-	-	-	5
Pepper	-	-	-	-	1	-	-	-	1
Sponge Gourd	-	1	-	-	-	-	-	-	1
Legumes	-	3	1	-	-	-	-	-	4
Selected Veg. ²	6	19	11	1	-	-	-	-	37
Veg. In General	-	2	14	3	3	1	-	1	24
TOTAL	14	40	40	4	4	1	1	1	105

¹ Included Food and Nutrition(1) and Integrated R & D

² Included combination of different vegetables, indigenous, leafy and solanaceous vegetables

Table 33. Ongoing Vegetable Research Budget by Agency and Research Area, Philippines, 1990-1999.

AGENCY	RESEARCH AREA							Total (P)
	Crop Production	Crop Improvement	Crop Protection and Pest Management	Postproduction and Crop Processing (P)	Seed Technology and Production	Socio-Economics and Marketing	Others ¹	
DA Reg. Offices	0	197,000	0	0	0	30,000	0	227,000
11	-	197,000	-	-	-	-	-	197,000
CAR	-	-	-	-	-	30,000	-	30,000
DA	236,000	-	-	2,794,700	73,000	-	-	3,103,700
BPI	-	39,000	-	-	-	-	-	39,000
DOST	3,358,401	-	-	-	-	-	-	3,358,401
SCU's	258,000	232,000	2,535,968	0	68,000	0	44,000	3,137,968
BSU	144,000	-	-	-	-	-	44,000	188,000
MMSU	40,000	-	-	-	68,000	-	-	108,000
PSPC	74,000	-	-	-	-	-	-	74,000
OTHER UPLB UNIT	-	232,000	372,848	-	-	-	-	604,848
UPLB-IPB	-	-	1,653,120	-	-	-	-	1,653,120
UPLB-NCPC	-	-	510,000	-	-	-	-	510,000
TOTAL	3,852,401	468,000	2,535,968	2,794,700	141,000	30,000	44,000	9,866,069

¹ Included Food and Nutrition (P44,000) only

The above-listed ongoing studies cost P9.9 million, of which P3.4 million and P3.1 million have been managed by DOST and SCUs, respectively. Among SCUs, UPLB gets the biggest share of P2.8 million (90%). The DA head office disburses P3.1 million, whereas two DA regional offices get P227, 000.

3.3.3 Technologies Generated and Disseminated

The Regional symposia on R&D highlights are held every year in 12 regions in the country. They serve as an important venue for R&D centers and stations to present technologies and obtain feedback from stakeholders about their appropriateness after series of trials and piloting. Technologies generated from the laboratories are also tested and piloted in the farmers' fields, the main responsibilities of the RIARCs. These technologies are ready for dissemination when they have met the following criteria: general adaptability, social acceptability, environmental safety, and availability of support services.

In 1994-1996, the NARS generated and disseminated technologies for high mungbean yield using the Philippine Seed Board approved varieties, Mg11, Mg2, Mg3 (Table 34).

Table 34. Vegetable research technologies generated and disseminated, Philippines, 1990-1997.

YEAR	MUNGBEAN	GARLIC	TOMATO
1990 – 1993	None	None	None
1994	<ul style="list-style-type: none"> Use of Nitroplus rhizobia for high mungbean yield 	<ul style="list-style-type: none"> Package of technology for garlic production, handling and marketing 	
1995	<ul style="list-style-type: none"> NSIC released mungbean PSB-Mg 11 or "Catipon" variety; 	<ul style="list-style-type: none"> Proper cleaning, drying and storage of garlic 	<ul style="list-style-type: none"> NSIC released PSB Tm-7 and PSB Tm-8
1996	<ul style="list-style-type: none"> NSIC released mungbean PSB-Mg1; PSB-Mg2; PSB-Mg3 		
1997	None	None	None

Source: PCARRD Research Highlights 1990-1997

• A package of technology was generated for garlic production, handling, storage and marketing. For tomato, NSIC released the tomato varieties PSB-Tm-7 and PSB-Tm-8.

The SCUs, lead by UPLB, had reported a number of vegetable crop technologies (Appendix Table 3) generated by its various research institutes. In plant breeding, for example, UPLB-IPB developed the technologies for micro-propagation, *in vitro* maintenance, and meristem culture of onion, garlic and shallots; *in vitro* selection and screening of saline-resistant tomato varieties; and identification/utilization of nitrogen-fixing capacity of selected vegetables. However, these further need refinements and verification in the farmers' fields as to their technical feasibility, economic viability, social acceptability, and environmental soundness.

On crop protection, UPLB-NCPC developed a rodenticide baiting system for various vegetable crops; biocontrol of plant parasitic nematodes; *Trichogramma* mass-rearing parasitoids for insect control; pesticide test kits; integrated weed management; and nuclear polyhedrosis virus (NPV) for insect control that are now ready for adoption.

On postharvest, UPLB-PHTRC developed technologies which reduce losses during non-refrigerated transport of tomato, such as the modified atmosphere packaging and ethylene absorbent which slow down the ripening of tomato; fabrication of sizers; optimized use of calburo, kakawati leaves, and squash peels for ripening; coconut water for preventing the yellowing of sitao; use of tawas for the control of cabbage rotting; and use of maleic hydrazide to minimize sprouting of onions.

Nevertheless, out of these technologies, vital research-based information were gathered and disseminated. Such information posed significant social and economic implications associated with technology adoption these too contributed to better understanding of research problems and gaps and help in the decision making of policy makers.

From 1991-1997, research-based information generated and disseminated were on mungbean, eggplant, tomato, garlic, cabbage, onion and asparagus (Table 35).

For mungbean, information disseminated were: planting of this crop after two succeeding lowland rice crops; the efficacy of its genotype in assimilation of symbiotically-fixed nitrogen; and farmer-managed seed production schemes for mungbean, among others.

For eggplant, variety EG 269 was found ideal for dry-season planting; accessions 85, 96a and 268 showed promising against shoot borer; accessions 85, 137 and 260 showed combined resistance to leaf-hopper and shoot/fruit borer.

For tomato, research-based information disseminated included: the off-season tomato varieties for Region 3; extent of pesticide use by tomato farmers in Nueva Ecija; bacterial wilt control in tomato; and screening of foreign tomato cultivars under local conditions.

Table 35. Vegetable research-based information disseminated, Philippines, 1991-97.

YEAR	MUNGBEAN	EGGPLANT	TOMATO	GARLIC	CABBAGE	ONION	ASPARAGUS
1991	<ul style="list-style-type: none"> Planting of mungbean after two succeeding lowland rice crops increases rhizobial cells in soil 	<ul style="list-style-type: none"> Eggplant variety EG 269 for dry season planting 					
1992	<ul style="list-style-type: none"> Efficacy of mungbean genotype in assimilation of symbiotically-fixed nitrogen Mapping morphological and isozyme markers in mungbean Multiple shoot induction in mungbean Inheritance of seed coat color of mungbean 	<ul style="list-style-type: none"> Control against eggplant shoot borer, <i>L. orbonalis</i> Guenee Eggplant accessions 85, 96a and 268 have promising resistance to shoot borer; accessions 85, 137 and 260 have combined resistance to leaf-hopper and shoot/fruit borer 	<ul style="list-style-type: none"> Effect of continuous fungicide applications on the disease complex of tomato 	<ul style="list-style-type: none"> New garlic strains (Cabuyao & Mindoro I) adaptable in Ilocos Norte Storage of garlic (piling) incurs least weight loss and insect pest infestation 			
1993			<ul style="list-style-type: none"> Off-season varieties (Maligaya, Marikit, & NC-11-1) for Region 3 				
1994		<ul style="list-style-type: none"> Extent of pesticide use by eggplant farmers in Nueva Ecija 	<ul style="list-style-type: none"> Extent of pesticide use by tomato farmers in Nueva Ecija 				
1995	<ul style="list-style-type: none"> Farmer-managed seed production schemes for mungbean 	<ul style="list-style-type: none"> Identification of Entomophthorales infecting insects on eggplant Efficacy of chemical pesticide (Sevin) against borers 	<ul style="list-style-type: none"> Relay cropping with tomato to control fungal diseases IPM for bacterial wilt in tomato 		<ul style="list-style-type: none"> IPM for DBM in lowland cabbage Postharvest losses of 21.5% in cabbage due to mechanical damage, rotting/decay and insect attack 		
1996			<ul style="list-style-type: none"> Postharvest losses on tomato due to poor harvesting, packing, transport and handling, lack of 	<ul style="list-style-type: none"> Use of gibberellic acid to improve size of garlic Effect of mulching on garlic yield in 	<ul style="list-style-type: none"> Biological control (<i>T. chilonis</i>) against cabbage moth IPM of DBM in Ilocos Region 	<ul style="list-style-type: none"> Multiplier onion production in the Ilocos Region 	

			appropriate storage and ripening facilities, lack of processing techniques	Batanes			
1997			<ul style="list-style-type: none"> • Screening of promising tomato cultivars from Indonesia, Malaysia, Thailand, Taiwan, and USA under Philippine conditions • Use of organic fertilizer for the production of off-season tomato. 	<ul style="list-style-type: none"> • Tissue culture of garlic 	<ul style="list-style-type: none"> • Heat-tolerant cabbage varieties (Summer Summit, Good Season, Hayo, Cabuko, & Extra Rare) for low elevation • Bt formulations and synthetic pyrethroid for pest control of cabbage in Bohol • IPM for clubroot in cabbage in Benguet • Use of organic fertilizer for off-season production of cabbage 		<ul style="list-style-type: none"> • Most common natural enemies of asparagus (spiders, coccinellid, beetles, meadow grasshopper, syrphid flies, braconods, praying mantis & bethylids)

Source: PCARRD Research Highlights 1991-97.

For garlic, information disseminated was on new garlic strains adaptable in Ilocos Norte; piling of garlic to lessen weight loss and insect pest infestation, use of gibberellic acid to improve size of garlic; and tissue culture of garlic.

For cabbage, information was focused in general, on integrated pest management for diamond back moth, and the potential of heat-tolerant cabbage varieties for lowland planting.

In onion and asparagus, onion production in Ilocos Region and natural enemies of asparagus were cited, respectively.

Technologies that have successfully passed the piloting stage and have high potential for commercial application are considered priority technologies for commercialization. When commercialized, these technologies could provide the best alternative for improving the income and productivity of a greater majority of people; provide solution to environmental sustainability, import substitution, export generation, and promotion of alternative foods.

Among the most significant vegetable technologies commercialized was the production of mungbean 'BPI Mg9' (or Taiwan Green) after rice in traditional growing areas in the country during the dry season (Table 36). The project covered 15,892 hectares with 30,871 farmer-beneficiaries in Regions 1, 2, 3, 5, 6, 8 and 10. The DA regional offices and local government units provided technical assistance and the seed requirement of the program. BIOTECH supplied the *Rhizobium* inoculant, whereas the Land Bank of the Philippines provided credit to farmer-cooperatives.

Table 36. Vegetable Research-based Technologies Commercialized 1992-1997.

YEAR	COMMODITY	PACKAGE OF TECHNOLOGY	SOURCE/COLLABORATORS
1992	Mungbean	<ul style="list-style-type: none"> Commercial production of BPI Mg 9 (or Taiwan Green) after rice in traditional growing areas in the country during dry season 	<ul style="list-style-type: none"> UPLB-BIOTECH AURDC BPI-Los Baños National Crops Research and Development Center DA-Region II
	Soybean	<ul style="list-style-type: none"> Commercial production of soybean in non-traditional growing areas following the harvest of the wet season rice (or corn) 	<ul style="list-style-type: none"> DA-Region II CLSU UPLB-BIOTECH BPI-LBNCRDC
1993	Soybean	<ul style="list-style-type: none"> Accelerated soybean production, processing and utilization through the establishment of contiguous soybean production communities and small scale soybean processing plant. 	<ul style="list-style-type: none"> DA-CVLMROS CLSU UPLB-IPB UPLB-BIOTECH UPLB-IFST
1994 – 1997		<ul style="list-style-type: none"> Expanded soybean commercialization 	<ul style="list-style-type: none"> DA-Region II UPLB-IPB BPI-LBNCRDC

Source: PCARRD Research Highlights 1992-1997.

3.3.4 Constraints to Technology Adoption

Despite the achievements claimed by the research system, constraints to technology adoption had continuously bothered policy makers affecting the growth of the agriculture sector. Various factors slow down the trickle of research and technological information to the end-users. Among these were: (1) national goal vis-à-vis farmers' needs; (2) organizational structure in the government; (3) limited supply of trained extension workers; (4) inadequate information; and (5) farmers' attitude toward technology adoption.

(1) National Goal vis-a –vis Farmers' Needs

Many opined that the root problem of low technology adoption in vegetable production is the research system's approach to problem identification. Problems are identified based on national goals, rather than on farmers' needs. There is a tendency on the part of the government to package technologies using top-down approach instead of participatory approach. As such, farmers have very rational bases for choosing the technology components they wish to adopt. In particular, farmers invariably adopted the components that would give them the highest economic returns. In mungbean and soybean commercialization, for example, farmers found it difficult to adopt the whole packages: they only chose the most feasible component for them. With this preference by the end-users, the purpose of technology packaging is defeated.

(2) Organizational Structure in the Government

The devolution of the extension system has created dysfunctional consequences to technology transfer. The devolved provincial and municipal agricultural officers (PAOs and MAOs) find difficulty in urgently responding and implementing the national programs and policies emanating from the DA. Their participation, somehow, depend on the approval, discretion, and priority of the local leaders.

At the barangay level, services are more concentrated in the distribution of planting materials and operation of farm produce, collection and buying stations. Such delineation of functions apparently creates the loose linkage of extension services from national bodies, up to provincial, municipal and barangay levels. The devolved provincial and municipal agricultural offices could hardly act on programs or pronouncements from the national bodies because the decisions and actions greatly depend on the approval of local leaders.

Among agrarian reform communities (ARCs), the devolution also has created setbacks on technology transfer and adoption. The lack of functional linkages and complementation between the ARCs and LGUs is more evident. Workplan and priorities served by the local agricultural technicians for extension services do not conform to the needs of the ARCs.

(3) Limited Supply of Trained Extension Workers

The research community and the extension system failed to translate in a more understandable form the results of studies for the farmers to appreciate better. The research sector relied on the capability of the extension agent to bring these results to the end-users. Limited effort from the research sector was exerted to get feedback from users of technology to further refine the technology and make it more relevant. The research system's efficiency depends in part on the degree to which they are informed of the problems of the farmers. Extension, on the other hand, could only be effective to the extent that they are professionally prepared and equipped to transfer technologies to end-users, to monitor the result of the transfer, and feedback relevant research information gathered. In this context, with the devolution, the LGUs were not prepared to assume such functions unless the assigned extension workers are trained with updated and appropriate technologies.

(4) Inadequate Information

Social scientists stressed that farmers are information seekers and that information is similar to any marketable commodity. Therefore, low technology acceptance is not only attributed to inefficient extension force. One important reason is the inadequacy of user-friendly information. While the research community plays a significant role in technology generation, the crucial test for the utilization of such is the extent to which the knowledge generated and the technology derived from it have been disseminated and utilized by the end-users. As a strategy, research findings or results should be translated into sets of recommendations that are understandable by end-users and fit specific agro-climatic and socio-economic conditions so that knowledge can be operationalized.

(5) Farmers' Attitude Toward Technology Adoption

The value system of the farmer is another consideration. To change the attitude of the farmers cannot be attained overnight. The farmer is a social individual whose practices are bound by his beliefs, culture and psychosocial competence. Social science research with focus on extension and communication could provide insights for better understanding of policy makers and development planners on the causes of slow rate of adoption by farmers.

3.4 Strengths and Weaknesses of the Institutional Structure of Research and Extension Linkage

The strength of the Philippine vegetable research-extension linkage lies in the participation of four government sectors: the DA (BAR and regional R&D stations), DILG (LGUs) and DOST(PCARRD) and the SCUs which are generally autonomous in nature.

From the DOST side, PCARRD is tasked to identify national research priorities and oversee the planning, coordination, and monitoring of researches in agriculture, forestry and natural resources. At the DA level, BAR realigns the department's research priorities to generate results, which are truly useful to farmers and fishermen. In the regions, the DA-RIARCs and ROSES are well in place to conduct verification trials and piloting of developed technologies.

Representing the academe is a pool of SCUs with technical expertise to undertake downstream-applied research and could best serve as training facility and propagate genetic materials. Research facilities and experimental farms, although inadequate in their present state have served as field laboratories to test, demonstrate and pilot the validity of research findings.

The enactment of the Local Government Code provides for the devolution of the authority over agricultural extension to LGUs, which was once lodged at DA.

In terms of policy pronouncements, the 1987 Constitution has acknowledged the active participation of non-government organizations (NGOs) and people's organizations (POs) in the affairs of the community. The LGUs, the NGOs and POs can no longer be ignored in charting agricultural development programs. Such defined structures render the NARS a firmer scientific foundation. In another perspective, however, what is seen ideal is far from reality. While the NARS has defined structure, problems of technology adoption still persist.

The above scenario provides an insight on the difficulty in coordinating research efforts of various agencies involved which do not fall within the same jurisdiction. The set-up bears weakness in terms of fund allocation by the government. These different agencies involved rely from the direct support from DBM more so, when such agencies give low priority to vegetable research. Funds earmarked for vegetable research is oftentimes diverted to other activities. Most research institutions generally used a portion of their budget for capital outlay, with very little left for operating expenses to support project implementation. There could be a good number of research stations, but because of meager budget, such stations cannot operate fully.

The lack of effective mechanisms for coordination and monitoring hinders the generation and pooling of data-base for vegetable-related studies which are vital in decision making of agricultural policy makers.

4.0 Conclusions and Recommendations

4.1 Proposed Research Areas

(1) Low Vegetable Consumption Research

One of the most pressing issues faced by the Philippine vegetable industry is the low consumption of vegetables. Considering the importance of vegetables in the human diet, the low level of consumption is more alarming from the nutrition or public health standpoint. The most urgent need, therefore, is for **research to determine the causes of low consumption and recommend ways to motivate Filipinos to increase vegetable consumption.**

(2) Varietal Improvement

Another problem, which may have contributed to low consumption, is the high cost of vegetables compared to other food staples. This reality suggests problems of high production and marketing costs, which should be solved by increasing yield potential and reducing production and marketing costs. In this regard, **research should be geared toward developing varieties that would give maximum yield and quality produce and tolerant to insect pests/ diseases and postharvest stress.** Varietal improvement should continue, as a high priority for vegetables because the use of improved varieties is the least expensive method of increasing yield and reducing production and postharvest handling costs. It is therefore recommended to pursue:

- Germplasm collection and evaluation of priority vegetables
- Varietal development for high yields, and good storage quality
- Development of off-season varieties of tomato, eggplant, onion, garlic, cabbage, and pechay
- Development of varieties under shaded condition
- Varietal development for host resistance in tomato (BW, TMV, CMV, late blight), eggplant (fruit worm, green leaf hopper, phomopsis), squash (fruitfly, leaf curl), mungbean (bean fly), shallot (purple blotch)

High priority should be given to the study of nutritional evaluation, genetic improvement and conservation of indigenous vegetable crops. Effort should include the collection, study of the botany, mode of reproduction, genetics and methods of utilization.

There is a need for the development of improved propagation techniques and improved husbandry for indigenous vegetables. More is known about methods of propagation and husbandry techniques for introduced vegetable

species. Lack of such knowledge of native vegetables hampers their production and utilization.

High priority should be given to organic farming of vegetables which in simple terms refers to home gardens. Agricultural research activities usually ignore utilization issues including those concerned with the nutritional impact of research activities. Thus, home gardening is rarely considered. Home gardens offer direct opportunity for equity in food accessibility.

(3) Crop Production

Efforts to increase production of vegetables have shown promising results. However, intensification of vegetable production is hampered by high production costs resulting from high price of seed or planting material and the relatively huge gap between yield in research plots and the average national yield.

The high-yielding vegetable varieties are mostly hybrid. Supply of hybrid seeds depends on import and therefore is too costly for small producers. Small farmers are able to purchase and plant seeds of local varieties, which are generally of low quality and low yielding, but do not require high inputs. The produce is of inferior quality and lacks uniformity. In response, research efforts should be directed toward producing seeds in the country, which are less expensive than imported ones, and varieties should be better adapted to local environments while maintaining their superior qualities.

Research has successfully produced technologies for increasing vegetable production. However, these are not fully applied by farmers. These discrepancies are reflected by the difference in yield obtained in the research plot and the average national yield. For research to address this gap, **more trials in the field, demonstration and pilot plots need to be conducted**. Specific studies must be conducted on the following areas:

- Cultural management strategies to maximize yields, quality and profit
- Development of alternative sources of nutrients and efficient water management
- Development of technologies for local seed production
- Development of production strategies for bio-intensive home gardens

(4) Integrated Pest Management

The relatively high cost of vegetable production leaves a limited degree for profit margin. The net return of farmers is not all the time sufficient to motivate them to grow more. The excessive use of agro-chemicals such as pesticides has added more input expenditures and causes serious pollution to the soil, water and produce.

On crop protection, **research emphasis must be on host resistance, cultural management and biological control using local resources (parasites, natural enemies and insect pathogens and pesticidal plants)**. Of equal importance, **research should focus on developing strategies to reduce the use of toxic chemicals**. Chemicals not only account for a high percentage of the production cost (estimated at 59%, 40% and 23% for cabbage, squash and ampalaya fruitly, respectively), but also pose health hazard to man and threaten the integrity of the environment. The rampant use of pesticides in vegetable growing areas in the country is a common knowledge among consumers, and is probably one of the reasons why they have low consumption of vegetables. It is therefore worthwhile to look into the following areas:

- Management of soil-borne pathogens affecting vegetables
- Studies on major virus diseases and insect pests for specific vegetable crops
- Identification, characterization of epidemiology and development of control strategies against major disease
- Pesticide residue and management strategy to some commonly grown vegetables

(5) Postproduction

Improper postproduction handling practices/technologies causes a high percentage of product losses. Gains achieved in increasing vegetable production will be useless or flow back to waste if high postproduction losses persist. For this reason, postproduction research areas need to be given due importance.

For the Philippine vegetable research, highest priorities should be on:

- Packaging and handling system improvement
- Quality standards, quality assurance system and food safety development
- Storage techniques and shelf-life improvement
- Postharvest tools and equipment

Together with technological advances in food processing, vegetables could be made available in value-added product from all year round. It becomes necessary therefore, that **research efforts be directed toward new product development** such as frozen vegetables, canned, juices or concentrates, sauces, dried and capsules.

(6) Socio-economics

There are evidences that small-scale farmers and even the urban consumers have benefited from agricultural technologies. However, this does not mean that advances in agricultural production have met the nutritional needs of the poor

segments of the society. Issues relating to low demand, food security, low commodity prices and international trade remain vexing. The solutions to these problems rest not so much with the biological scientists, but with the social scientists.

The above scenario warrants the need to pursue socio-economic research for vegetables, particularly in the following areas:

- Characterization of socio-economic and bio-physical environment
- Market prospects of fresh and processed vegetables
- Supply and demand analysis
- Impact assessment of technologies/programs
- Role of women in vegetable production/post-production and marketing systems
- Socio-economic constraints to technology adoption
- Government policies: trade and investment, credit and regulatory policies (e.g. IPRs)

The social dimension concerns of vegetable research should be taken into account, too. This points to the need for research to include from the beginning, and not as an after thought questions such as: What are the effects of available technologies (like improved varieties) on the farmers' income, food habits, welfare, and gender sensitivity? What are the farmers' risk taking behaviors in relation to their adoption of new varieties and technologies? How the biological and technological requirements in cultivating a new crop affect the overall socio-economic status of a farm family? To what extent and how the farmers participate in technology generation, technology transfer, and policy formulation? These questions can only be satisfied by social scientists who should be working with the technical research team to find out how the development and introduction of new technologies would affect the social and economic situation of farmers as end-users.

4.2 Proposed Roles of the Public and Private Sectors

The public sector is comprised of institutions and organizations of government line departments, SCUs, research centers and stations which address various areas of concerns. These public institutions at the national and regional levels of responsibility have profound macro level impact on the performance of vegetable research in the country.

In vegetable research, the visible role of the public sector is in the area of providing financial support, setting directions for research, coordination and monitoring, verification and fine tuning studies in the farmers' fields. Represented by the academe, the public sector also provides leadership in extension services, but more focused on education and training. With the devolution of the extension

system, the public sector represented by the LGUs, carries out technology transfer activities. However, availability and technical capacity of responsive extension workers is another constraints of the vegetable industry, which has resulted to poor and unyielding technology transfer. Worst, technology transfer is undertaken using informal channels which compound the problem of poor management practices by end-users.

In limited occasions, the participation of the private sector in vegetable research is very minimal. The SCU-private sector partnership in applied research has been experienced by few SCUs and seed/chemical companies. The latter's participation lies in the provision of material support (funds or supplies) and facilities to test the efficiency of their products.

The need to pursue vegetable research and address the constraints of the industry is great, but the capacity of the existing institutional research-extension structure is invariably limited. The call now is for interdependence. With the limited resources given to vegetable research, the pooling of efforts, specialization and sharing of responsibilities will redound to mutual and equitable gain of both sectors.

The following areas have been identified to describe a more effective complementation of public and private sectors' engagement in vegetable research.

(1) Contract Research

Collaborative research projects should be explored by public research institutions (funding agencies as well as research agencies) with private organizations that have advanced laboratories and facilities on biotechnology, seed technology, postharvest handling and processing. Private sector-led research will even lessen bureaucratic red tapes which have been claimed to slow down research activities.

Along the same concept of contracting research, DOST provides research funds to private individuals who will pursue studies on entrepreneurship as a result of technology application. On market research, DA commissions UA&P and FRLD to conduct competitiveness studies of selected crops and assess the existing market intelligence and promotion system, respectively.

(2) Demand-Driven Research

Need-based type of vegetable research should be prioritized. In technology development, the private sector (as the end-user) should take part from the beginning of the technology development and utilization flow. This concept could be realistically operationalized through consultation with the private sector (i.e. seed producers and processors). Figure 9 outlines the possible role of the private

sector from technology generation to technology transfer. From cultivar development, national trials, up to initial seed multiplication, the private sector should be given the opportunity to participate. After release of the variety by PSB, the private sector should be given the task to multiply in collaboration with LGUs in the conduct of field demonstration trials. This strategy may hopefully upgrade the technical capacity of the devolved extension agents.

The first private company that engaged in breeding and development of tomatoes was the Philippine Packing Corporation through the leadership of Dr. Juan C. Acosta. The company developed and released Improved Pope, a variety resistant to Biovar III of *Pseudomonas solanacearum*, with firm fruits. Today, this variety is grown throughout the country and found acceptable by traders because of its good shipping quality and longer shelf-life.

(3) Education and Training

As the natural homes of high level human resource complement, the public sector's (through the SCUs) role should be more visible in education and training. Education opportunities should be extended to private companies' technical staff. In return, SCUs should institutionalize the students' internship to private research companies.

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Appendix Table 1. Vegetable Production, Area Harvested and Yield, Philippines, 1990-1997

Vegetable Type	1990	1991	1992	1993	1994	1995	1996	1997	Average Annual Growth Rate (%)
Tomato									
Production ('000 mt)	184.0	177.2	165.4	138.5	150.6	155.8	162.6	166.4	-1.1
Area Harvested ('000 ha)	20.0	19.5	18.2	15.6	17.5	17.9	16.9	17.1	-1.9
Yield (mt/ha)	9.2	9.1	9.1	8.9	8.6	8.7	9.6	9.7	0.9
Eggplant									
Production ('000 mt)	112.7	104.0	110.4	111.7	123.5	130.7	157.6	195.0	8.6
Area Harvested ('000 ha)	16.4	14.5	15.5	17.4	17.8	17.6	18.1	19.0	2.4
Yield (mt/ha)	6.9	7.2	7.1	6.4	6.9	7.4	8.7	10.3	6.3
Cabbage									
Production ('000 mt)	117.2	170.9	150.8	155.1	151.3	130.0	98.1	95.9	-0.9
Area Harvested ('000 ha)	8.6	11.0	10.1	10.4	10.7	8.5	8.0	7.9	-0.3
Yield (mt/ha)	13.6	15.5	14.9	14.9	14.1	15.3	12.3	12.1	-1.1
Onion									
Production ('000 mt)	61.5	60.3	56.7	61.5	73.6	88.4	83.3	85.4	5.3
Area Harvested ('000 ha)	6.4	6.4	5.8	6.5	7.6	8.7	9.8	12.0	9.9
Yield (mt/ha)	9.6	9.4	9.8	9.5	9.7	10.2	8.5	7.1	-3.8
Garlic									
Production ('000 mt)	17.9	12.4	11.8	12.3	15.7	17.2	18.6	20.2	3.2
Area Harvested ('000 ha)	6.4	4.5	4.2	4.3	5.8	6.3	6.3	7.9	5.0
Yield (mt/ha)	2.8	2.8	2.8	2.9	2.7	2.7	3.0	2.6	-1.1
Mungbean									
Production ('000 mt)	26.7	25.1	23.2	23.4	24.2	26.7	26.8	27.5	0.6
Area Harvested ('000 ha)	36.7	34.3	32.7	33.1	34.0	34.9	35.5	36.4	-0.1
Yield (mt/ha)	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.6
Asparagus									
Production ('000 mt)	1.9	2.4	4.3	5.9	9.8	10.8	11.8	11.0	31.6
Area Harvested ('000 ha)	0.3	0.3	0.6	0.7	1.1	1.3	1.4	1.3	27.5
Yield (mt/ha)	7.3	7.9	7.8	8.9	9.0	8.4	8.5	8.3	2.1
Fruit Bearing Vegetables									
Production ('000 mt)	2,910.2	2,812.7	2,895.4	2,973.5	3,005.3	2,812.2	3,134.1	3,191.8	1.5
Area Harvested ('000 ha)	328.0	314.5	313.9	312.3	315.0	331.5	336.3	341.2	0.6
Yield (mt/ha)	8.9	8.9	9.2	9.5	9.5	8.5	9.3	9.4	0.9
Leafy/Stem Vegetables									
Production ('000 mt)	1,080.2	1,124.6	1,110.4	1,086.1	1,072.6	1,104.4	1,308.5	1,318.6	3.1
Area Harvested ('000 ha)	171.2	172.8	174.5	171.8	171.8	179.8	181.4	182.7	0.9
Yield (mt/ha)	6.3	6.5	6.4	6.3	6.2	6.1	7.2	7.2	2.1
Total Vegetables									
Production ('000 mt)	4,512.3	4,489.6	4,528.4	4,568.0	4,626.6	4,476.2	5,001.4	5,111.8	2.0
Area Harvested ('000 ha)	594.0	577.8	575.5	572.1	581.3	606.5	613.7	625.5	0.8
Yield (mt/ha)	7.6	7.8	7.9	8.0	8.0	7.4	8.1	8.2	1.2
Total Agricultural Crops									
Production ('000 mt)	61,566.5	64,109.3	63,837.4	65,766.5	68,525.6	62,164.8	69,128.5	68,301.4	1.7
Area Harvested ('000 ha)	13,096.3	12,983.7	12,520.4	12,549.0	12,786.9	12,574.8	13,015.6	13,024.7	-0.1
% of Agri. Crop Production	7.3	7.0	7.1	6.9	6.8	7.2	7.2	7.5	0.4
% of Agri. Crop Area	4.5	4.5	4.6	4.6	4.5	4.8	4.7	4.8	0.9

Source: Bureau of Agricultural Statistics

Appendix Table 2. Completed Researches for Philippine Vegetables, 1990-1997.

RESEARCH AREA/COMMODITY	PROJECT/ACTIVITIES
1. Crop Improvement 1.1 Eggplant	<ul style="list-style-type: none"> • Development of improved varieties through introduction and selection (DA-BPI)-LBNCRDC • Varietal improvement of eggplant (UPLB-IPB) • Evaluation of different eggplant varieties in Pangasinan during wet and dry season
1.2 Tomato	<ul style="list-style-type: none"> • Characterization of newly developed varieties of tomatoes (DA-BPI)-LBNCRDC • Varietal improvement (DA-BPI)-LBNCRDC and UPLB-IPB • Regional yield trial on fresh and processing tomato (DA-BPI)-LBNCRDC • Development of tomato lines with long shelf-life (DA-KCCDP) • Advanced evaluation and on-farm trials of saline-selected tomato somaclonal CV, Improved Pope and application of <i>in-vitro</i> screening protocol on other commercial cultivars (UPLB-IPB) • Genetic analysis and Molecular Mapping of Bacterial Wilt in Tomato • Differentiation of <i>Phytophthora infestans</i>, <i>Xanthomonas campestris</i> pv. <i>vesicatoria</i>, <i>Fusarium oxysporum</i> in tomato and virus affecting cucurbits and varietal resistance • Disease management and new approaches to the control of bacterial wilt (<i>Pseudomonas solanacearum</i>) in tomato and other vegetable crop plants • Breeding of rainy season tomato cultivar (hybridization of heat tolerant and water-logged resistant tomato cultivar) • Screening of tomato varieties for regional adaptability in Eastern Visayas • Evaluation on the yield and quality of fresh market tomato varieties in Pangasinan • Purification and production of breeder seeds of tomato • Germplasm collection, evaluation and maintenance of fresh and processing varieties of tomatoes • Variety trial of tomato as intercrop under coconut • Screening of tomato varieties in Eastern Visayas (grown after rice) • Varietal improvement of processing tomato under post-rice conditions • Resistance of tomato and other vegetable crops to root-knot nematodes • Resistance of tomato to cercospora leaf mold, gray leaf spot and major foliar diseases of tomato and other vegetable crops • Varietal improvement of tomato thru germplasm collection, evaluation, hybridization and selection (BPI Econ. Garden ES) • Preliminary yield trial of processing varieties of tomato • Screening and genetic improvement of vegetable crops for resistance to bacterial wilt and other bacterial diseases • Preliminary and general trials on AVRDC tomato (BPI Economic Garden ES) • Screening of accession with yield potential and processing quality • Yield and quality evaluation of promising breeding lines and/or varieties of promising tomatoes • Preliminary and general trials on AVRDC tomato (DA Misamis Oriental HRC)

1.3 Squash	<ul style="list-style-type: none"> • Germplasm collection, evaluation and selection (DA-BPI) • Development of inbred lines for the production of F1 varieties of squash • Development of processing varieties of squash both for flesh and seeds
1.4 Onion	<ul style="list-style-type: none"> • Varietal improvement evaluation of newly introduced varieties of onion (DA-BPI) • Varietal improvement in Alliums (onion, shallot and garlic)
1.5 Mungbean	<ul style="list-style-type: none"> • Development of improved varieties through germplasm collection, hybridization and selection (DA-BPI) • Introduction, evaluation and selection of breeding lines (DA-BPI) • Maintenance of breeder seed stock of seedboard varieties (DA-BPI) • Yield trial of mungbean • Screening for shade tolerant varieties of mungbean under coconut (DA-R11) • Varietal improvement studies in Region 2 • Rapid analysis for the detection and evaluation of genetic polymorphism in <i>Cercospora canescens</i> and <i>Sclerotium rolfsii</i> important fungal pathogens of mungbean, (UPLB-ODR)
1.6 Asparagus	<ul style="list-style-type: none"> • Varietal improvement: introduction, collection and evaluation of different varieties under low elevation areas (DA-BPI) • Development of tissue culture techniques • Biotechnology: <i>in-vitro</i> propagation • Development of component technology in Cagayan
1.7 Cabbage	<ul style="list-style-type: none"> • Piloting and verification of chinese cabbage 'Reyna Elena' • Preliminary yield trial on cruciferous crops • Preliminary and general trials on AVRDC chinese cabbage (BPI Econ. Garden ES and DA Misamis Oriental HRC)
1.8 Garlic	<ul style="list-style-type: none"> • Management of tangle top and root rot of garlic • Effect of planting dates on the incidence of tangle top and root rot of garlic • Distribution of host range of tangle top and root rot of garlic • Vector identification of tangle top disease of garlic
1.9 Other Vegetables Carrot and Pepper Cauliflower Broccoli Crucifers Cucumber/cucurbit Sponge Gourd Shallots General Ampalaya Upo Mushroom	<ul style="list-style-type: none"> • Variety trial (DA-R4) • Evaluation of physico-morphological characteristics in broccoli for screening of compatible line (DA-BPI) • Introduction, evaluation and selection of different cruciferous crops (DA-BPI) • Germplasm collection, evaluation and selection • Varietal improvement of indigenous cucurbits • Varietal improvement of traditional cucurbits • Selection and purification of luffa for sponge production • <i>In vitro</i> propagation of UPLB developed shallots for on-farm trial • Biotechnology: soilless culture of select vegetables • Breeding for improved varieties of vegetable (MMSU) • Hybrid and varietal evaluation • Genetic diversity of Phil. Strains of <i>Pseudomonas solanacearum</i> affecting vegetable crops with strain specific resistance • Vegetative propagation of selected highland crops using tissue culture methods • Acquisition, conservation, management and utilization of vegetable germplasm

	<ul style="list-style-type: none"> • Bulb crops breeding • Soiless culture of vegetable – UPLB-ODR • Screening and genetic improvement of vegetables crops for resistance to bacterial wilt and another bacterial disease UPLB-IPB • Collection, selection and evaluation of <i>Colocasia</i>, <i>Xanthosoma</i> and <i>Alocasia</i> • On farm trials and pilot production of vegetable crops in selected provinces. Part I. Pilot production of ampalaya, upo and squash in Aklan and Sorsogon • Part II. On-farm trials of improved varieties of vegetables • Pilot production of dry beans in Cagayan and Isabela • Micropropagation and on-farm trials of IPB developed shallots • Varietal improvement of indigenous cucurbits (squash, ampalaya, patola, upo) • Varietal improvement of traditional cucurbits (watermelon, melon, cucumber) • Varietal improvement of eggplant and pepper • Varietal improvement of semi-temperate vegetable legumes (garden pea, snap beans, dry beans) • Cooperative research project in vegetables • Varietal improvement and selection of crucifers and other semi-temperate crops • On-farm introduction of promising snap bean varieties for the high, mid and low elevation areas • Seed production and on-farm trials of dry beans • Morphology and cytogenetics of sponge gourd, <i>Luffa cylindrica</i> and <i>Luffa acutangula</i> and their hybrid • Characterization and evaluation of indigenous vegetable germplasm <ul style="list-style-type: none"> 1. Cytology and cultivated and wild type of <i>Momordica</i> character 2. Cytology and indigenous <i>Solanum</i> species 3. Biochemical characterization of <i>Solanum</i> and <i>Abelmoschus</i> • <i>Bacillus thuringiensis</i> endotoxin gene transfer to corn, pechay and chinese cabbage <ul style="list-style-type: none"> 1. Development of transformation systems • Wide hybridization in eggplant and sponge gourd and squash • Genetic studies in selected crops: mungbean, eggplant, tomato, sweet pepper, wax gourd and sponge gourd • Germplasm collection and characterization <ul style="list-style-type: none"> a. Mungbean b. Sweet potato, yam and taro c. Pepper and eggplant d. Forage and pasture • The prospect of predator habitation enhancement as a strategy in insect pest management on tomato and okra • Regional trial on sweet pepper • Mycelial fusion techniques in improving French and Shiitake strains • Varietal improvement of mushroom • Germplasm collection and maintenance, variety trial and evaluation • Varietal improvement/cultural management of hot pepper
Other vegetables	<ul style="list-style-type: none"> • Resistance of eggplant, okra, tomato, and pepper against leafhopper, thrips, fruitworm and other arthropod pests • Development of insect-resistant genetic stocks of selected crops • Host-plant resistance and biological control complementation in insect pest management

	<ul style="list-style-type: none"> • Genetic diversity of Philippine species of <i>Pseudomonas solanacearum</i> affecting vegetable crops and development of vegetable crops with strain specific resistance • The control of bacterial wilt (<i>Pseudomonas solanacearum</i>) by agricultural biotechnology • Screening for genetic improvement of vegetable crops for resistance to bacterial wilt and other bacterial diseases • Screening and genetic improvement of vegetable crops for resistance to virus diseases • Studies on bacterial wilt of tomato and pepper and anthracnose in pepper • Management of pepper viruses • Collaborative vegetable research program for Southeast Asia: AVNET (Phase I) • Research program on solanaceous crops in Pangasinan • Varietal improvement of crucifers and other semi-temperate crops • Preliminary test/evaluation of baby corn • Introduction, evaluation and selection of varieties of bulb crops • Regional trials of promising varieties of vegetables • Economics of seed production of selected varieties of vegetables • Collection and testing of exotic vegetables in Region 8 • Improvement of vegetable crops • Varietal trial project • Collaborative vegetable research program for Southeast Asia: AVNET (Phase II) • National varietal improvement project on vegetable crops • Evaluation and selection of promising lines of vegetables for hilly areas in Pampanga • Performance evaluation of some minor vegetables under various elevations of Nueva Viscaya • Introduction and selection of baby corn • Varietal improvement of cucumber, cantaloupe and patola through germplasm collection and evaluation • Varietal evaluation of different varieties of asparagus in the highland • Multi-location evaluation of tested tomato, muskmelon, watermelon and onion varieties • Off-season vegetables growing in Cagayan • Indigenous rainfed vegetable development project • Variety development of ampalaya, upo and patola • Varietal improvement of okra (<i>Abelmoschus esculentus</i> L. Moench) and squash (<i>Cucurbita spp.</i>) • Cultivar evaluation for tangle top and root rot resistance (garlic) • Resistance of eggplant, tomato, pepper and okra to green leafhopper thrips and other arthropod pests • Resistance of cucumber, melons and ampalaya to thrips, fruitfly and other important arthropod pests • Breeding for shade tolerance of corn and vegetables • Screening of germplasm materials in artificial shade structure • Morpho-physiological bases of selection for shade adaptation • Series of yield testing under coconut trees • Varietal improvement of baby corn through germplasm collection, selection and evaluation • Comparative study on the yield of locally and foreign produced seeds
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	<p>of pechay and radish</p> <ul style="list-style-type: none"> • Survey, collection and identification of indigenous vegetables in Bicol Region • Bulb crops breeding • Solanaceous and cucurbits breeding program • Screening and genetic improvement of vegetable crops for resistance to major virus diseases • Testing of AVRDC vegetable varieties in the Philippines (AVRDC-POP for vegetable research and development) • Regional adaptability trials on cucurbits • National cooperative testing project for vegetables • Research and development for grain legumes: varietal improvement project • Micropropagation and on-farm trials of UPLB-developed shallots (<i>Allium ascalonicum</i> Phase 2) • Enhancement of the biological nitrogen fixation potential of vegetable legumes • Microbe enriched biofertilizer and multistrain legume inoculants • <i>Bacillus thuringiensis</i> endotoxin gene transfer to corn, pechay and chinese cabbage • Cell and tissue culture of mungbean and other legumes • Efficacy of four crystal genes from local isolates of <i>Bacillus thuringiensis</i> against lepidopterous pests of eggplant and onion • Performance of vegetable legumes in a coconut-based cropping system • National vegetable legumes performance trials • New approaches to the control of bacterial wilt (<i>Pseudomonas solanacearum</i>) in tomato and other vegetable crops • Seed increase and farm introduction of advanced experimental varieties of indigenous vegetable (2 studies) • Contract to multiply, characterize and document the Southeast Asian vegetable germplasm collection • Collection, multiplication, characterization and documentation of local vegetable germplasm of the Philippines • Multiplication, characterization and documentation of germplasm of vegetable crops • Monitoring the genetic structure and variability in four sample sizes of 10 pollutions each of mungbean, okra & bittergourd over 4 cycles of regeneration using morphometric and electrophoretic techniques • Plant regeneration from organs, tissues and protoplasts of mungbean and mothbean • Advanced evaluation and on-farm trials of saline selected tomato somaclones cv. 'Improved Pope' and application of <i>in vitro</i> screening protocol on other commercial cultivars • Development of tomato (<i>Lycopersion esculentum</i> Mill.) lines with long shelf life (extended up to Dec. 31, 1995) • Physiology of yield in field legumes I. Mungbean (2 studies) • Minor legume crop breeding (ricebean) • On-farm testing of promising lines and varieties of grain legumes • Gene mapping in mungbean (<i>Vigna radiata</i> (L.) Wilczek) (3 studies) • <i>Bacillus thuringiensis</i> endotoxin transfer to corn, pechay and chinese cabbage • Wide hybridization and tissue culture of mungbean (<i>Vigna radiata</i> L. Wilczek) and related <i>Vigna</i> species in the Philippines
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	<ul style="list-style-type: none"> • Cowpea breeding (5 studies) • Varietal improvement of grain legumes for enhanced nitrogen fixation • Breeding soybean for seed and processing quality (4 studies) • Application of the decision support system for agrotechnology transfer (DSSAT) crop models in the Philippines: Validation experiments and genetic coefficient determination for soybean crop models • On farm trial and introduction of promising varieties of field legumes adapted to adverse environments • Biotechnology-assisted genetic improvement of mungbean for multiple and durable pest resistance • Biochemical and molecular mechanisms of tomato (<i>Lycopersicon esculentum</i>) resistance against bacterial wilt caused by <i>Pseudomonas solanacearum</i> • Non-specific biochemical responses of tomato as horizontal-type resistance factors against bacterial wilt • Indigenous rainfed vegetable development project: resistance of cucumber, melons and ampalaya to thrips, fruitfly and other important arthropods pests • Bacterial wilt of tomato and pepper • Pilot production and on-farm trials of vegetable crops in selected provinces (Part II-on-farm trials) • On-farm trials and pilot production of vegetable crops in selected provinces (Part I – Pilot production: Phase 2- On-farm trials on improved varieties of vegetables) • Seed production and on-farm trials of dry beans • On-farm introduction of promising snapbean varieties in high, mid and low elevation areas • Pilot production of dry beans in Cagayan and Isabela • Determination and characterization of resistance factors in mungbean (<i>V. radiata</i>) and rice bean (<i>V. umbellata</i>) against bruchid • Isolation and purification of the resistance factors in <i>Vigna radiata</i> and <i>Vigna mungo</i> against bruchid • Minor legume crop breeding (cowpea) • Genetic diversity of Philippine strains of <i>Pseudomonas solanacearum</i> affecting vegetable crops and improvement of vegetable crops with strain specific resistance • Tissue culture of corn, mungbean and related legumes • Wide hybridization and tissue culture of mungbean and related <i>Vigna</i> species in the Philippines (5 studies) • Legume genetics • Nitrogen utilization of mungbean, cowpea and soybean during pod development • Tissue culture and in vitro selection for salt tolerance in tomato (2 studies) • <i>Bacillus thuringiensis</i> against root rot disease in tomato and beans • Pilot scale production of dextran by local strain of <i>Leuconostoc mesenteroides</i> using coconut water by direct whole cell fermentation • Efficacy test of miracle booster on growth and yield of bush sitao • Enhancement of BNF in vegetable legumes • Characterization of indigenous rhizobia associated with beans and peas
Watermelon	<ul style="list-style-type: none"> • Varietal trial of watermelon in Pangasinan
Pechay	<ul style="list-style-type: none"> • Study on the monthly planting of pechay as influenced by the

	different levels of NPK on the yield and quality seeds
2 Crop Protection and Pest Management 2.1 Eggplant	<ul style="list-style-type: none"> • Influence of intercropping plant with herbs/spices on insect pests incidence (DA-BPI) • Development of improved varieties of eggplant • Studies on the ecology and chemical control of thrips palmy karny attacking solanaceous and other vegetable crops • Biology and chemical control of the eggplant fruit and shoot borer <i>Leucinodes orbonalis</i> Guenee (Lepidoptera, Pyralidae)
2.2 Tomato	<ul style="list-style-type: none"> • Influence of <i>Mycorrhiza</i> on <i>Fusarium</i> wilt of tomato (DA-BPI) • The effect of neem extract on tomato fruitworm in Davao City • NCT on vegetable tomato in Davao City • Determination of the effect of VAMF on root pathogens of tomato as possible control for root diseases • Strain difference of <i>Phytophthora infestans</i>, <i>Xanthomonas campestris</i> pv. <i>vesicatoria</i>, <i>Fusarium oxysporium</i> in tomato and virus affecting cucurbits and varietal resistance (UPLB-ODR) • Molecular mechanisms against bacterial wilt caused by <i>Pseudomonas solanacearum</i> (UPLB-IPB) • Biology and control of root knot nematodes in celery and tomato • Biological control of plant parasitic nematode of vegetable crops • Cultural control of root knot nematodes on tomato • Field evaluation of metribuzin for weed control in transplanted tomatoes • Tomato experiment • Pest succession study of tomato • Chemical evaluation of pesticides against tomato fruitworm • Studies on bacterial wilt of tomato and pepper and anthracnose/virus diseases of pepper (Phase I) • Study on bacterial wilt of tomato and pepper (Phase I) • Evaluation of the time of planting on the incidence of major pests and diseases of tomato • Biological control of tomato fruitworm (<i>Heliothis armigera</i> Hubner) using <i>Beauveria bassiana</i> • Utilization of plant extract as an insecticide for the control of tomato fruit worm
2.3 Onion	<ul style="list-style-type: none"> • Field evaluation of crushed neem berries against onion pests (DA-R3)
2.4 Mungbean	<ul style="list-style-type: none"> • Evaluation of Neem cake/oil in the control of mungbean pests (DA-R3) • Appropriate IPM approaches for mungbean pests and diseases: weevil management on storage pest (DMMMSU) • IPM approach: management of powdery mildew and <i>Cercospora</i> leaf spot on mungbean • IPM: diversity studies on insects (ISU) • Rapid analysis for the detection and evaluation of genetic polymorphism in <i>Cercospora canescens</i> and <i>Sclerotium rolfsii</i> important fungal pathogen (UPLB-ODR)
2.5 Asparagus	<ul style="list-style-type: none"> • Crop protection studies
2.6 Cabbage	<ul style="list-style-type: none"> • Elevation of <i>Diadegma semiclausum</i> Hellen against diamondback moth on cabbage under Benguet Condition-2 studies (DA-BPI0) • Survey and control of diseases in the Cordillera (DA-BPI0) • Crop protection: control of bacterial soft rot

	<p>important fungal pathogens of mungbean, <i>Vigna radiata</i> Wilzeck</p> <ul style="list-style-type: none"> • Mushroom research and development program • Studies on bacterial wilt of tomato and pepper and anthracnose/virus diseases of pepper (3 studies) • Improvement of tropical indigenous vegetable crops II • Screening and genetic improvement of vegetable crops for resistance to root-knot and other major nematodes (4 studies) • Screening and genetic improvement of vegetable crops for resistance to major virus diseases (5 studies) • IPM in mungbean: weed management • IPM in vegetables (tomato and stringbeans) • Biological and cultural control of bacterial wilt of solanaceous crops and cabbage soft rot • Biological control of diamond backmoth in cabbage • Establishment of maximum residue limits for pesticide residues in mungbean • Weed management in vegetable crops • Management of tomato fruitworm • Demo-experiment on optimization of inputs for vegetable production • IPM in vegetables: Development of IPM for beans • IPM in vegetables (tomato and stringbeans) • Control of diamond backmoth in cabbage • Laboratory evaluation and rearing of the potential natural enemies of cabbage moth, <i>Crociodolomia binotalis</i> Zeller • Establishment of maximum residue limits of insecticide in mungbean, watermelon and cucumber • Damage assessment of bean leaffolder, <i>Lamprozema indicata</i> on mungbean • Field evaluation of score 250 EC to control fungal diseases of vegetables (tomato, eggplant, pole sitao) • Control of cabbage insect pest by <i>Metarhizium anisopliae</i> • Pesticide residue data generation for the establishment of maximum residue levels in cabbage, tomatoes, eggplant and stringbeans • Nematode management in tomato • Club root disease of cabbage and its management strategies • Studies on crop complementation: Intercropping for the control of diamond back moth and tomato fruit worm • Vegetable pest management program • Crop protection information on vegetables • Weed management in vegetables • Response of selected dryland weed species to Metribuzin, Pendimethalin and ADS • Mass rearing of different pests of economic crops for slide production and compilation • Field evaluation of tissue cultured <i>Allium</i> • Studies on bacterial wilt of tomato and pepper and Anthracnose and virus diseases of pepper • Ecological studies • Chemical control • Crop protection studies on selected vegetable crops under Central Luzon condition • Identification, distribution and control of vegetable diseases in the Visayas
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	<ul style="list-style-type: none"> • Crop protection studies on some selected vegetable crops • Ecological succession and seasonal abundance on the insect pests and beneficial insects associated with vegetables • Continuous screening of pesticides for the control of insects and diseases on vegetables under the "Gulayan sa Kalusugan" program • Microbial pathogens of insect pests in vegetables • Use of metarrhizium anisopliae for the control of major lepidopterous insect pests in vegetables • Survey, identification and pathogenecity test of nematodes associated with vegetables in Davao Experiment Station • S4-Effect of continuous application of fungicides on the disease complex of solanaceous vegetables
2.10 Mushroom	<ul style="list-style-type: none"> • Crop protection in mushroom • Collection, identification and biology of insect pests of cultivated mushrooms • Collection, identification and biology of mushroom diseases • Insecticide control of mushroom flies • Fungicide control of mushroom truffle and damping-off diseases • Disease transmission of French mushroom spawn substrates to newly planted beds
2.11 Cucumber	<ul style="list-style-type: none"> • Regional adaptation trial on pickling cucumber
2.12 Watermelon	<ul style="list-style-type: none"> • Evaluation of pyrethroid, OP and carbamate insecticide against pest of watermelon
2.13 Solanaceous	<ul style="list-style-type: none"> • Disease management in solanaceous crops • Distribution and control of bacterial diseases of solanaceous crops • Population dynamics and chemical control of nematodes attacking solanaceous vegetables
2.14 Pepper	<ul style="list-style-type: none"> • Study on Anthracnose of pepper (Phase I) • Study on viruses of pepper (Phase I)
2.15 Ampalaya	<ul style="list-style-type: none"> • On-farm verification trial on ampalaya • Varietal trial on ampalaya • Development of inbred lines for the production of F1 varieties of ampalaya
3 Crop Production	
3.1 Eggplant	<ul style="list-style-type: none"> • Preliminary yield trial • Seed multiplication • Effect of organic fertilizer on the yield
3.2 Tomato	<ul style="list-style-type: none"> • Culture and management cropping pattern study with tomato as base in relation to incidence of wilt disease • Protective culture on indeterminate tomatoes for wet season planting • Response of tomato to N, P and lime application on Adtuyon clay soil • Varietal screening of tomato for rainy season planting • Evaluation of promising AVRDC tomato varieties for off-season planting
3.3 Vegetables	<ul style="list-style-type: none"> • Cultural management practices and socio-economic profile of Ilocos Norte growers of garlic and onion • On farm trials on vegetables: tomato; eggplant • Study on the off-season production of vegetables in the Visayas • On farm fertilizer trial on green corn • Variety x fertilizer trial for vegetable • Evaluation of rainy season tolerant early varieties of squash, ampalaya and watermelon after upland rice under Bicol condition • Study on different composted farm waste as a source of organic

	<p>fertilizer for vegetables</p> <ul style="list-style-type: none"> • The influence of the agroclimatic condition on the incidence of insect pests and diseases at different planting dates of tomato and eggplant • Study on the harvesting time of baby corn • Varietal resistance of tomato and eggplant cultivars in the incidence of fruitworms in Pangasinan • Row and hill spacing of eggplant and tomato • Fertilizer requirements of eggplant and tomato • Crop protection project • Studies on field plot techniques in vegetable production • Mixed inoculant for field legumes study 2. Production of mixed inoculant • Pilot testing on effectiveness of rhizobium and VA mycorrhiza in increasing growth and yield of peanut, mungbean and soybean • Utilization of legume-rhizobium-mycorrhizae interaction in mungbean and soybean production under acid soils
3.4 Crucifers	<ul style="list-style-type: none"> • Varietal improvement of crucifers and other semi-temperate crops • Integrated management approach against clubroot of crucifers
3.5 Cabbage	<ul style="list-style-type: none"> • Seed production studies on chinese cabbage • Feasibility of AVRDC chinese cabbage on seed production
3.6 Melon	<ul style="list-style-type: none"> • Economics of producing off-season melons
3.7 Cucumber	<ul style="list-style-type: none"> • Pollination of cucumber (<i>Cucumis sativus</i>) density of honeybees needed for effective pollination
3.8 Cucurbits	<ul style="list-style-type: none"> • Effect of pruning on the production of marketable fruits of ampalaya and upo • Chemical modification of flower sex expression pattern in cucurbits
3.9 Squash	<ul style="list-style-type: none"> • Performance of selected strains of squash as intercrop with coconut • Performance evaluation of squash varieties/strains under Davao condition • Development of improved varieties of cucurbits thru hybridization and selection • Multi-location studies on corn-squash
3.10 Pepper	<ul style="list-style-type: none"> • Fertilizer requirements of hot pepper • Row and hill spacing of sweet pepper during early dry and wet season • Fertilizer requirements of hot pepper • Growth and yield response of sweet pepper varieties to different planting dates • Weed competition studies in sweet pepper
3.11 Mushroom	<ul style="list-style-type: none"> • Influence of planting dates on the yield of mushroom (<i>V. volvaceae</i>) • Survey, collection, identification, testing and cultivation of edible fungi for food • Spent compost as casing soil • Rejuvenation of mushroom beds • Low cost housing for French button mushroom • Old shiitake bed logs as spawning materials • Cost and return analysis in composting rice straw • French mushroom growing patterns • Soil types and mixtures as mushroom bed casing soil • Suitable spawn substrates for French button mushroom • Forced fructification of shiitake bed logs • Suitable compost moisture level during packing • Highland mushroom research and development program • Cultural production techniques development

4. Crop Processing 4.1 Vegetables	<ul style="list-style-type: none"> • R & D in legume and oilseeds • Mechanism and texturization of vegetable proteins • Oligosaccharides in indigenous legumes • Characterization of plant cell wall polysaccharides in mungbean (<i>Vigna radiata</i> L. Wilzek), kadyos (<i>Cajanus cajan</i>) and tapilan (<i>Vigna umbellata</i> Thumb.) • Polyphenols and tannins in vegetables and fruits • Frozen vegetables (5 studies) • Development of quality sauces from blends of tomato and squash • Development of dehydrated products from selected leafy vegetables • Development of dehydrated and powdered sweet pepper and tomato for table use
4.2 Garlic	<ul style="list-style-type: none"> • Verification of existing package of technology on postharvest handling of garlic
4.3 Cabbage	<ul style="list-style-type: none"> • Field evaluation on the efficacy of <i>Trichogramma</i> species against diamondback moth (DBM) (<i>Plutella xylostella</i>) on cabbage
5. Postharvest Vegetables	<ul style="list-style-type: none"> • Alternative treatments to extend the shelf life of selected vegetable crops • Handling trials for vegetables and cutflowers cum action project (packing and transport storage, socio-economics rapid appraisal, design, fabrication and evaluation of equipment) • Soilless culture of vegetables • Handling trials on tomato
6. Socio-Economics/Crop Utilization 6.1 Vegetables	<ul style="list-style-type: none"> • Socio-economic evaluation and policy analysis of the pilot mungbean technology commercialization program • Marketing mushroom • Postharvest handling, processing and marketing • Prolonging shelf life of French mushroom with growth retardants • Drying method for Shiitake mushroom harvested during rainy season • Packing materials and containers in maintaining quality of fresh mushroom during transport • Mushroom preservation • Varietal trials of okra during wet and dry season planting • Sorption of some dehydrated and candied fruits and vegetables • Storage of leafy vegetables in evaporative/ventilated coolers • Storage studies using treatment combination (evaporative/ventilated cooling plus plant extracts) • Development of quality sauces from blends of tomato and squash • Dehydrated products from leafy vegetables • Chlorophyll retention in leafy vegetable using plant extracts
6.2 Tomato	<ul style="list-style-type: none"> • Postharvest handling of tomatoes
6.3 Crucifers	<ul style="list-style-type: none"> • Non-refrigerated storage of leafy vegetables
6.4 Broccoli	<ul style="list-style-type: none"> • Development of techniques in producing quality broccoli seeds and other related crops
7. Crop Physiology 7.1 Vegetables	<ul style="list-style-type: none"> • Screening for drought and water logging resistance in vegetable crops

Appendix Table 3. Crop Protection Technologies Generated/Developed from the Completed R&D Projects by Type of Vegetable and Agency, 1990-1998.

TYPE OF VEGETABLE	AGENCY	TECHNOLOGIES GENERATED
Crop Protection Tomato	MMSU DA-SMIARC IPB	<ul style="list-style-type: none"> • Use of assassin bug, <i>E. furcellata</i> reduces tomato fruit worm infestation from 50%-5%. • Wild accessions, 76w and 77w were the least preferred by fruitworm for larval feeding and oviposition • Reducing bacterial wilt incidence in tomato using burned lime; dried chicken dug, and tomato varieties, Marikit and Maigoya • Identified 4 late-blight resistant lines from Taiwan
Cabbage and Other Crucifers	RCPC-Region 10 DA-STIARC ROS DA-NOMIARC BNCRDC BSU	<ul style="list-style-type: none"> • *<i>E. furcellata</i>, a predatory bug, as potential bio-control agent against armyworms, cutworms, DBM and semi-looper • *Makabuhay and yerba-buena at 10% as effective control against DBM and cutworm • *Release fo 500 Cocoons of <i>Cotesia plutellae</i> increased parasitism to 35-57% • *Intercropping of cabbage and tomato reduces DBM population due to volatile compound emitted by tomato which caused a repellent effect on adult DBM. • Deltamethrin spraying effective to control <i>Diadegma semiclausum</i> (12.5 to 100% mortality rate, 1-6 days after spraying) • Highest ROI of 169% was obtained from <i>Diadegma</i> combined with Bt; reduced insecticide cost from 10-60%. • Use of <i>Diadegma</i> against DBM increase where pesticide usage is minimal • *Fungicidal application using copper oxychloride gave the least mean clubroot severity index
	MMSU	<ul style="list-style-type: none"> • <i>Cotesia plutellae</i> reduces the number of insecticide spraying from 24-36 times to 2-3 times/cropping with comparable yield.
Selected Vegetables	DPP-VISCA	<ul style="list-style-type: none"> • <i>T. chilonis</i> (egg parasitoid) and spotted ladybird beetle (predator) as potential bio-control against DBM
Onion	DA-RCPC	<ul style="list-style-type: none"> • Neem Kernels as potential control against onion pests
Solanaceous Vegetables	VISCA DA-CENVIARC ROS	<ul style="list-style-type: none"> • Continuous applications of Dithane M-45 and Maneb suppressed <i>Sclerotium</i> wilt; Benlate is most effective against leaf mold; Maneb controlled both diseases of tomato; Fungitox and Captan are more effective against fruitworm and mirid bug • Cymbush and Malathion markedly reduced the population density of natural enemies • <i>P. lilacinus</i> is as effective as Nematicur 10G in controlling root knot nematode
Garlic	MMSU	<ul style="list-style-type: none"> • Spraying of Malathion and Profenofos at 4 tbsp/16 li. of water two weeks interval to control mites and thrips • Relay cropping increased the income of garlic and tomato farmers

	DA-DES	<ul style="list-style-type: none"> • Sevin, Malathion, Roxion, Discarsal, Baythroid, Azodrin 202 R and Decis are moderately effective against thrips during early infestation
Vegetables	VISCA MMSU IPB	<ul style="list-style-type: none"> • Identified <i>Paecilomyces lilacinus</i> fungal egg parasite, as a control agent of RKN • Pigeon pea is a good trapcop against tomato fruitworm • Identified sources of resistance to bacterial wilt • Identified 4 resistant lines in OFT in 2 sites • Identified soil solarization, summer plowing, grafting soil amendment and use of microbial antagonists as effective control methods.

*For techno-demo

Appendix Table 3. Crop Production Technologies Generated/Developed from the Completed Vegetable R&D Projects, by Agency, 1990-1998.

TYPE OF VEGETABLE	AGENCY	TECHNOLGIES GENERATED
Crop Production Tomato	DA-Region III MMSU DA-Region VII, Mandaue, Experiment Station	<ul style="list-style-type: none"> • Packaged recommended production technologies using Maligaya, Marikit, and NC-11-1 for off-season planting in Bulacan and Nueva Ecija • Recommended 035 XN, 048-2XN and 062 XN for seed production and commercialization • Recommended cultivar (LS915-93 and FMTT 138 for farmers during wet and dry season
Cabbage	Bohol-APC	<ul style="list-style-type: none"> • Heat tolerant varieties; KY Cross, Leo and Express were found adapted to lowland conditions, with average marketable yield of 20 t/ha, 18.7 t/ha and 18.5 t/ha respectively; varieties are disease resistant, but susceptible to DBM
Onion	MMSU NOMIARC	<ul style="list-style-type: none"> • Use of Granex 429 for salad preparation • Red Creole and multiple onion showed resistance • Recommended Eagle Select Hybrid and Granex 33 and Granex 429 • Recommended Genotype 195B for off-season planting (July-August) and 22SB during regular planting
Garlic	MMSU	<ul style="list-style-type: none"> • Tan Bolters was the most promising garlic cultivar with dry bulb yield of 3.69 t/ha. • Ilocos Pink was resistant to thrips and to diseases such as cercospora leaf spot, purple blotch, and root rot at all growth stages • GA3 application at 250 ppm was the most profitable with 6626.67 kg/ha and net benefit of P674.8 or Marginal Rate of Return of 874%. • Recommended varieties are Tan Bolters, Ilocos White, Ilocos Pink, Cabuyao and Mindoro, in Regions 1, 2, and 4.
Asparagus	BNCRDC	<ul style="list-style-type: none"> • Promising entries were 186 x 202-27.4 t/ha, 168 x 175-25.6 t/ha/yr and 162 x 163-25.7 t/ha/yr which are moderately resistant to pests and diseases
Semi-temperate Vegetables	DA-STIARC	<ul style="list-style-type: none"> • KK Cross outyielded Topmost, Pluto, Marion Market, Rareball during the wet and dry seasons; Rareball and Pluto were resistant to DBM, but late maturing.
Solanaceous	VISCA	<ul style="list-style-type: none"> • Recommended varieties 8h-2 and Pt06 which produce more number of marketable fruits
General Vegetables	CLSU	<ul style="list-style-type: none"> • ANT-43 (48.1 t/ha) outyielded national check Bonan (14.02 t/ha), but was comparable to Apollo with 41.61 t/ha • FMTT 138 produced the highest yield of 1.52 t/ha of check (0.89 t/ha); application of pure IOF and ½ IOF and OF was better.
Selected Vegetables	LBNCRDC	<ul style="list-style-type: none"> • ANT 22 (2.4 t/ha) and ANT 7(23.9 t/ha) outyielded the check (23.7 t/ha), obtained 30.2 t/ha average yield using AVNET varieties compared to local check (28.3 t/ha) • Identified high yielding varieties of tomato from Taiwan

Sources: PCARRD and IPB-UPLB

Appendix Table 3. Postharvest and Processing Technologies Generated/Developed from the Completed Vegetable R&D Projects, by Research Area and Agency, 1990-98.

RESEARCH AREA/TYPE OF VEGETABLE	AGENCY	TECHNOLOGIES GENERATED
Postharvest Garlic	MMSU	<ul style="list-style-type: none"> • Piling was the best method for storing garlic. It was found to have the least weight loss and number of insects • Lagundi leaves as underlay or overlay while drying bulbs repel storage pests • In storage, bulbs treated with chemical pesticides such as Carbaryl repelled storage pests; bulbs treated with botanical materials or inert dusts before storage minimized losses due to a major storage pest, the cigarette beetle <i>Lasioderma serricorne</i>. • Spread the lagundi leaves, sea sand, sand dunes or lahar in between and on top of piled garlic bulbs. • Application of dried crushed lagundi (<i>Vitex negundo</i>) leaves on top of piled garlic bulbs at the start of storage reduced incidence of cigarette beetle by 6.33%. • Covering the bulbs of each layer with the leaves of the succeeding upper layer prevents sunscalding which markedly affects quality of bulb. • Sevin, Malathion, Roxion, Discarsal, Baythroid, Azodrin 202 R and Decis are moderately effective against thrips during early infestation
	DA-DES	
Processing	MMSU	<ul style="list-style-type: none"> • Garlic can be processed by chopping and pulverizing; fabricated a machine that can chop at 60.8 kg/h freshly harvested garlic and 28.2 kg/ha for old stock garlic with an efficiency of 96.67%. It can pulverize at 40.57 kg/ha freshly harvested and 6.49 kg/ha old stock garlic.

Appendix Table 3. Technologies Generated/Developed from the Completed Vegetable R&D Projects, - NCPC and PHTRC, UPLB, 1990-1998.

AGENCY	TECHNOLOGIES GENERATED	STATUS
NCPC-UPLB	<ul style="list-style-type: none"> • Rodenticide baiting system for various crops • Biological control (Biocon) of plant parasitic nematodes • Trichogramma mass rearing-parasitoids for insect control • Pesticide test kits • Integrated weed management • Nuclear polyhedrosis virus (NPV) for insect control • <i>Beauveria bassiana</i> – pathogenic fungi for insect control • <i>Metarhizium anisopliae</i> – pathogenic fungi for insect control 	<p>Adapted</p> <p>Adapted</p> <p>Adapted</p> <p>For dissemination</p> <p>On-going field verification</p> <p>On-going field verification</p>
PHTRC-UPLB	<ul style="list-style-type: none"> • Technologies which reduce losses during non-refrigerated transport of produce <ul style="list-style-type: none"> - Modified atmosphere packaging (MAP) (reduce oxygen and /or increase carbon dioxide to reduce biological activity effect: slower ripening of tomato and slower deterioration of okra - Ethylene absorbent (slow down the ripening of tomatoes) • Fabrication of postharvest equipment for more efficient operations <ul style="list-style-type: none"> - Sizers • Developed and improved village level technologies <ul style="list-style-type: none"> - Optimized use of calburo, kakawati leaves, and squash peels for ripening tomato - Coconut water for preventing the yellowing of sitao (it contains cytokinins which prevent yellowing) - Tawas treatment for the control of cabbage rotting (has antibacterial property; rotting control is as much as 70%). • Showed on commercial scale that maleic hydrazide can minimize sprouting of onions 	<p>Adapted</p> <p>Adapted</p> <p>Adapted</p> <p>Adapted (a barangay in Quezon)</p> <p>Adapted</p> <p>Adapted (90 has of onions are being treated with it)</p>

Source: UPLB-NCPC and PHTRC

Appendix Table 3. Crop Improvement Technologies Generated by Type of Vegetable and Funding Agency, IPB-UPLB, Philippines, 1990-1998.

TYPE OF VEGETABLE	FUNDING AGENCY	TECHNOLOGIES GENERATED	STATUS
Crop Improvement Tomato	USAID-Israel/IPB	<ul style="list-style-type: none"> • Protocol for callus culture from leaf explants • Protocol for plantlet regeneration from salt treated calli • Protocol for <i>in vitro</i> selection for salinity resistance • Protocol for <i>in vitro</i> screening for salinity resistance • Somaclones with potential resistance to salinity 	n.s.
	UPLB-IPB	<ul style="list-style-type: none"> • Micropropagated plants of four somaclones of CV 'Improved Pope' for seed production and further field evaluation 	n.s.
	IPB-UPLB-CA	<ul style="list-style-type: none"> • Development and utilization of selected somaclones under saline condition 	n.s.
	IPB-UPLB	<ul style="list-style-type: none"> • Standardization of the growing mix (in terms of available nutrients and pH) which minimizes inconsistent ratings or crop responses to inoculation during screening for disease resistance in tomato and other crops. • Identification of resistant accessions; integration of bacterial wilt management systems. 	n.s.
Pechay and Chinese cabbage	DOST-IPB	<ul style="list-style-type: none"> • Modified protocols for micropropagation and potting out for locally bred shallots • Protocol for callus culture and plantlet regeneration in pechay 	n.s.
Onion	UPLB Basic Research	<ul style="list-style-type: none"> • Protocol for callus culture for three commercial tomato cultivars 	n.s.
	ADB/AVRDC/PCARRD/IPB-CA	<ul style="list-style-type: none"> • Protocols for <i>in vitro</i> bulblet formation in garlic and shallots • Protocols for potting out of tissue cultured allium • Production of 61 sets from tissue cultured allium 	n.s.
Garlic/Shallots	ADB/AVRDC/PCARRD/IPB	<ul style="list-style-type: none"> • Protocol for micropropagation • Protocol for <i>in vitro</i> maintenance • Protocol for meristem culture 	n.s.
Selected Vegetables	IPB-UPLB	<ul style="list-style-type: none"> • Development of salt resistant crop varieties (corn, tomato, peanut and white potato genotypes) 	n.s.
	IPB-UPLB	<ul style="list-style-type: none"> • Identification and utilization of nitrogen-fixing capacity of pole sitao and snap beans and their contribution to N economy and 	n.s.

		<p>economic benefits derived from N-fixation (estimation of BNF contribution to pole sitao and snap beans production)</p> <ul style="list-style-type: none"> • Development of off-season production for a number of vegetable crops for adaptation by vegetable growers 	
Ampalaya	IPB-UPLB	<ul style="list-style-type: none"> • Commercial production of Sta. Rita variety • Identification of physiological and pathological causes of "namamarako" syndrome in ampalaya 	n.s.
Squash	IPB-UPLB	<ul style="list-style-type: none"> • Commercial production of Rizalina (A-193-1-1) 	n.s.
Onion/Shallots	IPB-UPLB	<ul style="list-style-type: none"> • Efficient micropropagation technique and field establishment of <i>in vitro</i> cultured shallots 	n.s.
Eggplant	IPB-UPLB	<ul style="list-style-type: none"> • Identification of resistant accessions of eggplant against leafhoppers • Identified mechanism resistance of eggplant against leafhoppers 	n.s.
Shalom (S2T45) Identified three (3) Salt-tolerant tomato Somaclones	IPB-UPLB	<ul style="list-style-type: none"> • Variety release: Squash: A-193-1-1 (Rizalia) Patola: Mestisa I • Variety release: Cucumber: UPLCu-6 (Pilmaria) UPLCu-11 (Bituin) • Efficient micropropagation technique and field establishment of <i>in vitro</i> cultured shallots • Recommendation of onion shallot and garlic varieties with better bulb qualities • Recommendation of crucifer and other semi-temperate crops varieties adapted to low, mid and high elevations • Commercialization of Sta Rita, Rizalina and 1042-1 • Recommendation for release of EMP 211 and Alubia Cerillos in Cagayan • Improved varieties of snapbeans for the high, mid and low-elevation areas • Reliable and efficient inoculation techniques for bacterial diseases • Information on etiology and epidemiology of some major diseases • Identification of some possible physiological and pathological causes of "namamarako" syndrome in ampalaya 	

n.s. – not stated

Source: IPB-UPLB